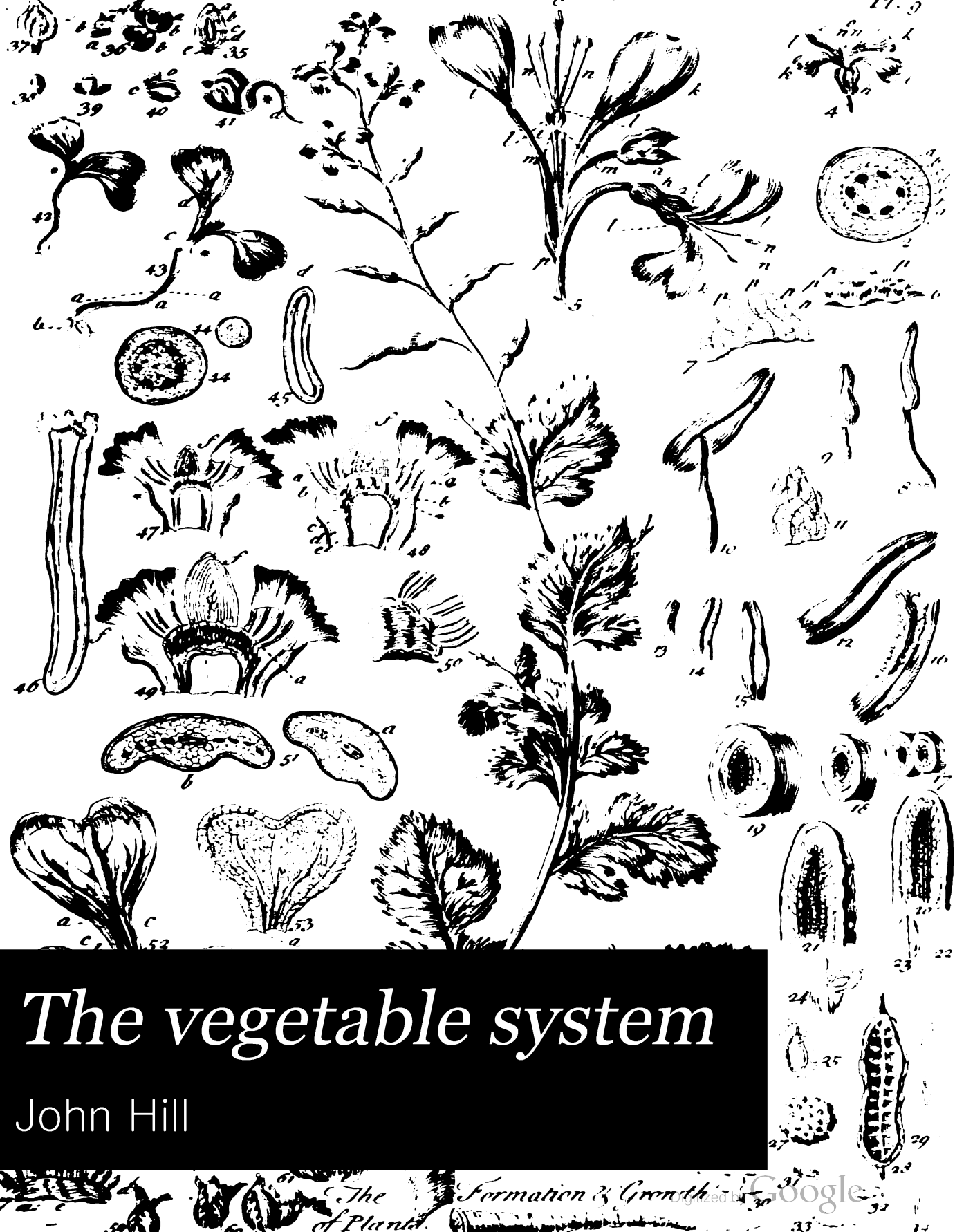


The vegetable system

John Hill

THE

VEGETABLE

SYSTEM.

50, 300
Dec 14, 1918
Trans from Cecil Lab

THE

VEGETABLE SYSTEM.

OR,

A SERIES OF

EXPERIMENTS, and OBSERVATIONS

TENDING TO EXPLAIN

The INTERNAL STRUCTURE, and the LIFE of PLANTS; their GROWTH, and PROPAGATION;

The NUMBER, PROPORTION, and DISPOSITION of their CONSTITUENT PARTS; with the true COURSE of their JUICES;

The FORMATION of the EMBRYO, the CONSTRUCTION of the SEED, and the ENCREASE from that State to PERFECTION.

INCLUDING

A NEW ANATOMY OF PLANTS.

The WHOLE from NATURE only.

By JOHN HILL, M. D. 1716-75.

LONDON:

Printed at the EXPENCE of the AUTHOR,

And Sold by R. BALDWIN, in Pater-Noster-Row.

MDCCLIX.

TO

HIS ROYAL HIGHNESS

THE

PRINCE OF WALES.

MAY IT PLEASE YOUR ROYAL HIGHNESS,

CONSCIOUS of the Difficulty of this Subject, and of my unequal Talents, it is with great Diffidence I have preſumed to lay before Your Royal Highneſs the following Reſearches: Yet, howſoever imperfect they may be found, I perſuade myſelf they will not be denied the Honour of Your Sacred Patronage, ſince they tend to the Advancement of a Science which wants, and (if the humbleſt of its Votaries may be allowed to ſay it) deſerves Protection:

Protection: which diſplays the GLORY OF GOD more than all others, becauſe we underſtand it better; and demands an equal Preference in its Utility to Man; as it ſupplies the Means of Life, and Health; and furniſhes many eſſential Articles, for the ARTS and COMMERCE.

THE certain Tendency of Botany to theſe great Ends, cannot fail to recommend it to the Favour of Your Royal Highneſs; ſince the World ſees, with Joy and Pleaſure, they are the Objects of Your higheſt Care. It is hence, we preſage that they will continue to flouriſh among us; PIETY from Your own great Example; and COMMERCE under Your peculiar Protection. The Favour of Heaven thus obtained, we doubt not will give that Succeſs to our Arms which ſhall command an honourable Peace, and its natural Attendant, laſting Proſperity.

MAY it pleaſe Your Royal Highneſs to pardon the Eye that looks thus far into Futurity; and ſees, with Tranſport, the Fruit of your great Virtues; Virtues which would make common Men eſteemed, but which muſt render a Prince adored: Theſe promiſe, SIR, to make Your native Country not only the moſt powerful, but the moſt reſpected of the World; eminent

nent for Virtue, and for all Improvements: under their Influence, we doubt not we ſhall ſee Britain celebrated as the Land of Knowledge; and the now famous Names of LEWIS and of COLBERT, eclipſed by greater of our own.

IT is with this View, we preſume to hope, that the continued Patronage of SCIENCE, tho' the leaſt, may yet be one of the many Glories attending Your great Name; and that, when the Wreathe of loftier Fame is filled, SHE may annex her Laurels; which tho' light, are yet eternal.

I have the Honour to be, with the moſt perfect Duty,

may it pleaſe Your Royal Highneſs,

Your Royal Highneſs's

moſt humble

and devoted Servant,

LONDON,
May 4, 1759.

JOHN HILL.

THE HISTORY OF BOTANY.

BOOK I.

INTRODUCTION.

Of the Origin of a Knowledge of Plants.

PLANTS muſt have been known, in ſome degree, at all times; for they could not eſcape man's obſervation. The Tree which gave him ſhade, the Fruits he eat, the graſs that fed his cattle, could not be uſed un-named: nor is it poſſible he ſhould neglect the fragrance of the Violet; or overlook the colours of the Roſe and Poppy. The Poet could not paint the Spring without them; nor the firſt Shepherds tell their ſons what Herbs their ſmall flocks fed upon with health, or which infected them with ſickneſs, till there were terms for their diſtinction.

THE origin of ſciences lies hid behind that cloud which obſcures all early Hiſtory; but ſo much as here is ſaid is plain from reaſon. We cannot doubt but before ORPHEUS or MUSÆUS, HESIOD or HOMER ſung

their qualities, the few Plants they have named were known among the peaſants of their country; or that diſeaſes had been cured by Herbs before the fabled CHIRON; or his days whom we ſee deified under the name of ÆSCULAPIUS: before the Hebrew SOLOMON, or SYRACH. What the CHALDEANS taught to docile ÆGYPT, they learned from ſome more early nation; and GREECE, which borrowed the Egyptian learning, owed the firſt rudiments of knowledge to that un-named people who were their teachers. The volumes of PYTHAGORAS on Plants were of avowed Egyptian origin; and thoſe of that DEMOCRITUS they celebrate, were but other ſtreams from the ſame ſource. In the mean time, while Learning laboured in the trodden path, the Savage taught himſelf: and GREECE and ROME, the ſeats of ſcience and of power, found, like their younger ſiſter BRITAIN, improvements even in their remoteſt conqueſts.

THUS, at all times, and every where, there muſt have been a knowledge of the Forms and Uſes of ſome Plants: but this yet was not Botany. Greece gave the firſt outlines of a philoſophic diſtinction; and that not in her earlieſt periods; for though HIPPOCRATES wrote uſefully upon their Virtues, and the ſcarce known CRATÆVAS told their Forms, the Father of the ſcience was THEOPHRASTUS. He the firſt of mankind, ſo far as hiſtory informs us, conſidered Vegetables in their Origin and Structure, their Principle of Life, and various Growth, and ſtruck out from the chaos a Philoſophy of Plants.

BOTANY had thus its firſt Eſtabliſhment in ANCIENT GREECE, four hundred years before the Chriſtian æra: and it was there conſidered as a ſcience; a ſingular and very noble part of natural philoſophy. Such it began, and ſuch it ended, among that celebrated people. Inſtead of thoſe advances and improvements which ought to have been expected under the ROMAN government, it drooped, and ſunk into a trivial art; converſant in names alone, and the ſlight characters marked on exterior forms. The ARABIANS were the next who cultivated it; and they imperfectly: 'twas loſt in the twelfth century, amongſt the general WRECK OF LETTERS; and reviving toward the end of the fifteenth, with the RESTORATION OF LEARNING, grew again, in the SIXTEENTH, into a ſcience, in the northern EUROPE.

WE are to trace its Hiſtory thro' this extent of time; which its various conditions naturally divide into thoſe ſix Periods.

PERIOD

PERIOD THE FIRST.

The Eſtabliſhment of Science in ancient GREECE.

CHAP. I.

The BOTANY of THEOPHRASTUS.

THEOPHRASTUS, a great and a diſcerning writer, diſtinguiſhed himſelf early among the GREEKS in Botany, and became the founder of the ſcience. He ſtudied Plants as a philoſopher; thoſe who wrote before him having conſidered little of them, except their medicinal virtues: He appears, therefore, in the honourable liſt of original Writers, and as the firſt of them on this ſubject. He ſtudied Vegetables as Vegetables; ſearching, in their conſtruction and appearances, their nature, origin, and cauſe of growth. On theſe enquiries he beſtowed all that attention which diſtinguiſhed him to the period of his very long life; and in declaring what he had thus learned concerning Plants, he diſcloſed all that eloquence for which his maſter, ARISTOTLE, named him the DIVINE SPEAKER. No EGYPT gave this parent of the ſcience his firſt rudiments, nor did he adopt from any his deſign: his was a ſubject left untouched by his celebrated maſter in philoſophy; and it was all his own: the book of nature lay before him, and in that only he appears to have read. From that alone he deduced thoſe obſervations and definitions on which he eſtabliſhed his ſyſtem; and made Botany a ſcience.

To view the exterior forms of Plants, to write an index of their names, or trace the nice diſtinctions of one ſpecies from another, in their minute organs, was no part of the undertaking: his was a greater ſubject; and to have known but one Plant, as he examined them, is greater than to have delivered the mechanic marks, or got by rote the more than the ſeſquipedalian names of our whole thirteen thouſand. Thoſe who object to this author's works, as imperfect, ſeem to miſtake his purpoſe. To ſay he knew but a few Plants, is raſh: for he has named thoſe only which ſerved his proper deſign. Theſe are about five hundred; and it is more the modern indolence, than the obſcurity of the ſubject, which prevents our

knowing what almoſt all of them were. That he ſays little of their virtues, can be no reproach; for he did not write on medicine. We own, and we lament, that his deſcriptions are often ſhort; but neither was this any part of his deſign. He treated of the Laws of Vegetation in Plants commonly known; and he names them as ſuch. We cannot foreſee what may be the fate of letters: perhaps two thouſand centuries hence, when after a vaſt ſpace of renewed Barbariſm, arts and power may have ſeated themſelves in the remote AMERICA, ſome haſty writer may, in the ſame manner, arraign the Britiſh THEOPHRASTUS, HALES, for not giving the virtues of the SUN FLOWER; or deſcribing more at large, the HOP-PLANT and the APPLE-TREE.

THERE remains yet one objection more to this great Founder of Botanic Knowledge; very general, but as unjuſt as theſe: it is the obſcurity of his writings. We muſt not wonder this is often named; for it is a faſhion to read Greek authors in the tranſlations: and it has been the ill fate of this writer, to be moſt unhappily rendered into other languages. Even the elegant GAZA, tho' he has done juſtice often to the language of THEOPHRASTUS, has failed extremely in the articles of ſcience: for only one who had ſtudied the ſubject could, in this part, underſtand the author. Perhaps this difficulty might have been, in ſome degree, removed, if that BODÆUS, who happily, tho' tediouſly, illuſtrated ſome of the writings of this author, had not left the greateſt work of all untouched. Thoſe who will read THEOPHRASTUS in the original, will find theſe cavils vaniſh; and will in every part admire how vaſt a genius, and what obſervation he has diſcloſed; what attention to nature, and what diſcernment in her operations.

HE propoſes his great undertaking as a philoſophical, rather than an hiſtorical performance; and firſt treating Plants as Plants, not as of this or that peculiar kind, he ſeeks their nature and their laws only from themſelves: deducing the new ſcience from theſe four ſources: 1. Their conſtruction, and their natural and eſſential parts. 2. Their peculiarities. 3. Their origin and propagation. 4. Their life. This is indeed properly the whole ſubject: farther obſervations may ſhew more wonders in theſe ſeveral articles; and new diſcovered countries afford additional ſpecies, wherein to trace them; but the ſource and true foundation of the ſcience lies in theſe four enquiries.

AFTER the common and received diſtinctions of the ſeveral natural parts of Plants, the ROOT, the STEM, the BRANCHES, and the like, he enters upon the conſtruction of theſe, and their conſtituent matter. The eſſential

essential parts of Vegetables he accounts to be three; the BARK, the WOOD, and the PITH: a nicer distinction shews they are more numerous; for the Bark is double, and there is always a distinction of what he calls the Wood, into a HEART, and BLEA. This THEOPHRASTUS also knew: but a plain simplicity of thought, was his character in these researches. He treated the two barks as making but one substance, because the one is generated from the other; and it is the same in the Blea and Heart of Wood. This observation may be necessary, to prevent little cavils: but the philosophy is the same with or without the division. The enquiring spirit of this ancient sage did not stop here. As the Root, Stem, and the like, were natural to Plants, he found also certain constituent parts essential to each of these; and existent in them always. These he accounts to be four: 1. A fleshy substance. 2. and 3. Vessels of two kinds; which he calls Veins and Fibres; and 4. The fluid matter contained in them. We now know that there are also membranes; and that various juices fill the different vessels. All this he also knew certainly, for he could not discover so much as he has explained, without also finding this: but in the same strain of plain simplicity, he reduces these also to their principles.

THUS did THEOPHRASTUS, taught by just observation, construct the Vegetable body. These parts he determined to be essential to Plants, as Plants; and in this he adds, the universal Nature of Vegetables consists. A Plant being thus constructed, requires, says he, two principles of Growth: these are HEAT and MOISTURE. Consequently when these fail, the Plant decays and dies.

THIS is his general system. Not only the silence of history before the time of THEOPHRASTUS, gives us reason to conclude the philosophy was all his own; but his manner of expression also claims that honour. He is too modest to say of every article, this no one knew before; or this is my invention; but he complains, throughout the whole course of his enquiry, of the want of terms; of words and names for the objects which he saw, and for his own conceptions. If others had written of these things before, names would most probably have been established for them. He supplies the want of them usually by definitions; and borrows sometimes names for several objects from the known parts of animals; tho', as himself acknowledges, they are not altogether analogous.

A FIBRE, he defines to be a part of a Vegetable body, which is long, continuous, and fissile lengthwise; and which terminates without the production of a head, or any other natural part of the plant.

A VEIN,

A VEIN, he diſtinguiſhes as larger than a Fibre, long, hollow, and filled with a fluid; theſe alſo, he ſays, may be ſeparated lengthways.

THE FLESH, he deſcribes as ſpungy, ſhapeleſs, and equally capable of being divided in all directions.

A BODY compoſed of theſe parts, and capable of extenſion and growth, by theſe allotted means, Heat and Moiſture, he defines to be a Vegetable. As very different Plants may be, and are conſtructed of theſe parts, and as the ſubject, when we proceed to the ſeveral ſpecies, becomes very copious, he adopts, for a familiar and plain general diviſion, the received diſtinction into four kinds, according to the ſtature of the body, and firmneſs of its ſubſtance; TREES, SHRUBS, UNDER-SHRUBS, and PLANTS. Under the name Tree, he comprehends ſuch Vegetables as are large, and riſe with a ſingle woody ſtem, as the oak: by Shrubs, he underſtands thoſe which riſe with many woody ſtems from the ſame root, as the Alder: by Under-Shrubs, ſmall Vegetables with a ſingle woody ſtem: and by Plants, ſuch as have tender leafy ſtalks. The author expreſſes his ſenſe of this diſtinction as vague and indeterminate, but, notwithſtanding, uſeful: and ſo all authors ſince have judged of it. It is impoſſible to fix what are the diſtinctive characters between Tree, Shrub, and Plant; yet mankind have always conceived their abſolute difference. The article of SUFFRUTICES, UNDER-SHRUBS, as we call them, has more perplexed thoſe who adopted this diviſion, than any other: but the character of theſe eſtabliſhed by THEOPHRASTUS, which makes them Vegetables, more firm and durable than the herbaceous kinds, between the Trees and Shrubs in nature, but below both in ſtature, is, in ſome degree, correct. A Suffrutex, he ſays, riſes with a ſingle woody ſtem, but is low and little; and he gives Rue as an inſtance.

HAVING thus eſtabliſhed a philoſophy of Plants; and form'd, or adopted rather, a diviſion of the ſpecies under a few natural claſſes, he proceeds to the ſecond article of his original deſign, their PARTICULARITIES, their natural differences, and the effects of culture: and in all this he is clear, diſtinct, and full of knowledge. Among the Particularities or Affections of Plants, he conſiders largely the various places of their growth; Earth, Freſh Water, Sands, and Seas: and from this ſource he gives another natural and obvious diſtinction of them, analagous to that of animals; into Terreſtrial, Aquatick, and Amphibious, naming many inſtances of each kind. To this article of the Particularities of Plants, he refers alſo the difference of their juices; their various taſtes, and ſcents: ſearching theſe qualities in that original difference of their juice; and that difference itſelf

in the formation of the Plant. He has done this very happily: ſparing of words, but full of ſenſe and matter.

HIS commentators have indeed been, like modern Critics, raſh and rude: they have depreciated their author, becauſe they did not underſtand him: for there required to this a knowledge of the ſubject as well as of the language. Of this it will be juſt, at the cloſe of the account, to give ſome inſtances. Having conſidered the Particularities and Affections of Vegetables in theſe and many other circumſtances; deducing their qualities from their ſtructure, according to his firſt philoſophy, the author proceeds to their origin, generation, and production; in wild nature, or by the arts of CULTURE. In this article we muſt be aſtoniſhed as we read, to find how much he knew: and we ſhould bluſh at the ſmall improvements of more than two thouſand years.

THE propagation of Trees from Seed, from Suckers, and from Cuttings, even the moſt tender, was familiar to him: nay the very reveries of Ratiſbon Agricola, had their foundation here: for THEOPHRASTUS names the method of producing Trees from pieces cut from the roots, trunk, and branches. What appeared miraculous when the mad German propoſed it to the world, might have been found earlier in this ſober GREEK; and Rome tried, and verified it in the Olive. So much we ſpeak of the antique knowledge; and ſo very little we examine what it was. Grafting and Inoculation, with all the leſſer arts of Tranſplantation, and the mechanick proceſſes of Culture, were known to THEOPHRASTUS. To take his ſenſe entire, we muſt read his ſeveral works on the ſame ſubject together; and we muſt read them in his own words, not in the ſtrange tranſlations, even of his beſt interpreters: thus we ſhall do him juſtice; and we ſhall then learn, that the new things are old; and learned labour is a thouſand times employed, to revive a neglected practice, for once that it attempts to raiſe a new one.

FROM this general doctrine of Culture, THEOPHRASTUS deſcends to the particulars: he ſpeaks with great and approved truth of Tillage and Manures; and among his various inſtances of the effects of Culture, he gives that famous one, of making the Bitter Almond ſweet. He treats largely of the Palm; and we find he knew very well its different ſex: and in the raiſing of the Fig, he explains, juſtly and truly, the ſtrange practice of Caprification. He deſcribes the Inſects of the male Wild Fig, and tells us how they eat their way into the fruit of the other. The writers upon Plants of a late time, when they perceived the difference of ſex in various Herbs of the ſame ſpecies, by a ſtrange abſurdity, gave the name

of

of *Male* to that which bore the Seeds: the Cynocrambe is an inſtance: but the Greek judged otherwiſe. He ſays, where the Plants are of two ſexes, the Male is barren. There is alſo a peculiar thought upon this ſubject in his writings, worthy a nice regard, tho' propoſed with great modeſty: it is, that Trees may be produced from their flowers, without the ripening of Fruit or Seeds. Let us be cautious how we reject this thought: It is ſtrange, in the higheſt degree, but it is not abſurd. 'Tis certain, that which grows into a new plant, is originally lodged in the Farina of the flower: and it is not impoſſible, in favouring climes, and in particular ſpecies, that THE FARINA MAY BE CAPABLE OF GROWTH. Perhaps, what we call Seeds in Fern, are globules of Farina; for we ſee no previous male flowers: moſt certainly the ſeeds, as they are called, of Truffles are of this nature: yet they grow. It is a doctrine to be propoſed with caution, but it is worth a tryal. He who gives the hint, has ſeldom been miſtaken: and if there ſhould be ſuch a power in nature, we may propagate this way, perhaps, ſome of the beſt Trees in our Stoves, which flower with us, tho' they do not ripen ſeeds.

AFTER this doctrine concerning the Origin and Generation of Trees, in which, tho' faintly, and as it were, fearful of cenſure for the novelty of his opinions, he propoſes many ſuggeſtions of the Original of Plants, conformable entirely to the philoſophy which experiments are now about to eſtabliſh, he comes to his fourth article, the Life of Vegetables.

THIS he conceives to exiſt in its firſt principles, in the Juices lodged within thoſe veſſels which he diſtinguiſhes by the name of Veins: and that as it is put in motion by the two principles, Heat and Moiſture, the Plant enjoys a ſtate of actual life; and grows. Having eſtabliſhed the Life of Plants upon this principle, he proceeds to examine the different extent of it in various kinds, and the occaſional decays which may effect it. This part of his works contains many and curious obſervations upon the Life, Health, and Diſtempers of Trees and Herbs. His obſervation that the Water Plants are ſhorter lived than thoſe which grow on Land, is a general, tho' not an univerſal truth: nor is it leſs ſo, that wild Trees are longer lived than thoſe of gardens. Abundant nouriſhment, in each caſe, gives a quick growth; but, like animal bodies over-fed, theſe are the more ſubject to diſorders and decay. In deducing the cauſes of the diſtemperatures of Trees, he lays the foundation of moſt of them, upon an exceſs of nouriſhment; and attributes the immediate cauſe of ſeveral diſeaſes, to ſharp ſeaſons after mild, in the time of their budding. What our late obſervations have done, numerous and particular as they have been, is

prin-

principally the confirming the doctrines long ago advanced by this great man. He eſtabliſhes Oil as the great Vegetable Poiſon; and gives this curious inſtance, that where Roots are cut, if they be rubbed with Oil, they ſhoot no Fibres.

THE Philoſophy of Vegetable Bodies having been conſidered under theſe diſtinct articles, and the propoſitions relating to each, illuſtrated by plain, and often very ſingular facts, the author proceeds to treat of the more conſiderable and uſeful Plants diſtinctively: obſerving, that when the general laws of Vegetation are known, it will be eaſier to underſtand the effects which they produce in the particular ſubjects. Under theſe heads he has conſidered principally the objects of utility: he has treated largely and judiciouſly of the Eſculent Herbs, particularly of the Corn and Pulſe kinds; and the ſeveral methods of raiſing theſe, have led him to conſider the Garden and Field Culture. We have accordingly in the ſucceeding chapters, the true Principles of Huſbandry and Gardening. He lays down alſo the beſt Seaſons for Felling Trees, and the Management of Timber; the Manner of preſerving Gums, and other Medicinal Juices; and gives the original Way of Making Pitch and Reſin: concluding his great work with a rational Account of Vegetable Medicines; and expreſſing a decent contempt for the fables and follies of an earlier time, relating to their growth, and to the manner of collecting them: every where conforming himſelf to nature.

THIS is a ſhort view of what THEOPHRASTUS wrote concerning Plants. His work appears a vaſt and well conſidered undertaking; where the Philoſophy of Vegetable Nature is made the baſis of all ſucceeding knowledge; and is extended to whatever is uſeful in the parts of Plants, their Products, and their Culture. Upon the whole, we find that ſomething was known concerning Plants before his time; but that knowledge was rude and indigeſted. Whatever former ages had diſcovered, we ſee collected and arranged in his ſeveral additional chapters, and carefully diſtinguiſhed from his own. The firſt has its uſe: but the great value is in the latter. Others had ſeen things, he examined them; they had experienced, but he reaſoned. We ſee him ſtanding alone, in the vaſt ſpace of Antiquity, with nothing before him, that deſerves the name of ſcientific knowledge; and very ſlow advances after him. What he had done, diſcouraged for many ages, thoſe who followed him; and while himſelf felt ſenſibly, and modeſtly acknowledged, that his advances were full of imperfection, referring the more accurate knowledge of things to ſucceeding times, and to repeated obſervations, his ſucceſſors thought he had exhauſted the whole ſubject:

ject. That there are ſome errors among this abundance of uſeful knowledge he has bequeathed the world, none can doubt: for what production that is human, is without them? but they are fewer than have been ſuppoſed: and it has been this author's ill fate, to be betrayed moſt of all by thoſe who ſhould have been his protectors; the great names *Gaza*, *Scaliger* and *Bodæus*, cannot diſguiſe, nor ſhould they hide this truth. A very little of the real excellencies of this Father of the Botanic Science, have been underſtood; and he has been cenſured for faults not his own. They have ſtumbled at the very threſhold; and the worſt accuſations which have been urged againſt his knowledge, have ariſen from their errors who rendered into other language his firſt chapter. One ſtriking inſtance may ſtand in the place of many; and it will be juſtice to his memory to give one.

CHAP. II.

Of the GRECIAN BRYUM.

THEOPHRASTUS propoſing to ſpeak of the parts in Plants, diſtinguiſhes the permanent from thoſe which are of ſhort duration. Thus the root, the trunk, and branches of Trees, he obſerves, are permanent; but they have other parts which riſe and fade within the year: ſuch are the Flower, and thoſe Films which cover and defend it in the Bud; the Fruit, and the like temporary products. The Buds of Trees, encloſing and defending the rudiments of their Bloſſoms, are compoſed of certain filmy ſubſtances, which fade as the Flower burſts forth; periſh utterly when that tender part no longer wants them; and never are renewed. This cluſter of filmy ſcales about the rudiments of a Flower, THEOPHRASTUS calls, in his own language, Βρύον, a name which has been ſince rendered Latin, and applied to a peculiar Genus of the Moſſes. GAZA, ſuppoſed an accurate tranſlator, has rendered this word *Muſcus*; and THEOPHRASTUS has been, in conſequence, accuſed of thinking Moſs a part and natural product of the Tree whereon it grows.

THE application of the word Bryum to that peculiar kind of Moſs which is now called by it, is later by many ages than the time of this venerable author. The word was then the abſolute name of a peculiar Plant, which THEOPHRASTUS himſelf mentions in its proper place; and it would have been impoſſible either that they ſhould have thought the word meant Moſs, or that THEOPHRASTUS thought the Plant it did mean, was a part of

of Trees, or ever grew upon them, if they would have taken him altogether; if they had read his fourth book before they had criticiſed his firſt.

THE Bryum of the ancient Greeks, was the Small Green Sea Weed, which the common Writers on Plants call LACTURA MARINA, and the vulgar, from the colour and place of growth, OYSTER GREEN. This Plant THEOPHRASTUS has not only named but deſcribed, in the ſeventh chapter of his fourth book, where he treats of the other Sea Plants. He refers it to the ALGAS, and ſays it is of a Graſs-green colour, with a curled and ſpreading leaf, not unlike the curled Lettuce, but more waved and wrinkled: he adds, that it has no ſtalk, and that it grows under the ſea-water, but in ſhallow places, on ſtones and potſherds, which happen to be there. This then was plainly the Plant called abſolutely Bryum by the Greeks; ARISTOTLE mentions it, and THEOPHRASTUS has deſcribed it; and it is impoſſible, that he who knew it a Sea-Plant, ſhould place it upon Trees at Land. The fact is this; the young leaves, or firſt ſhoots, of Oyſter Green, being thin, filmy, and curled about, reſemble not amiſs thoſe periſhable films which make the ſubſtance of the buds in certain Trees: therefore the Greek calls that filmy matter in buds figuratively Βρυον, the Bryum of the Gems of Trees; and after him his countrymen applied it to the Hop, becauſe that fruit is filmy; and to the Olive Bud; Βρυον was the term for the flowering of that Tree. THEOPHRASTUS laments frequently the want of proper terms and names for what he is to deſcribe; and in the ſame manner as here from another Vegetable, he often forms them on the names of parts ſomething like in the bodies of animals, acknowledging the imperfect and improper expreſſion, but pleading the neceſſity. It is thus they are embarraſſed who beat the untrodden paths of ſcience; and it has happened often, that they are thus rewarded: but ſeldom by ſo reſpected names as thoſe which join the cenſure upon THEOPHRASTUS.

THE word Βρυον was in after times uſed as the name of a TREE Moss, particularly of the long hairy kind. This is nothing to the ſubject when we are conſidering THEOPHRASTUS; tho', perhaps, 'twas this which led his Tranſlators into the error. We find the meaning of the word abſolute in his own writings: it was the name of that Sea Weed, and of nothing elſe, till himſelf uſed it figuratively for theſe films of buds. Indeed no term ever became more vague in its ſignification than this did afterwards. All Moſſes, all Excreſcences on Trees, and every thing of like kind, obtained the name of Bryum.

DIOSCORIDES, who wrote of Plants as Medicines, has limited the ſenſe of Bryum to one of the Tree Moſſes, us'd in ſome officinal compoſitions;

but the ſucceeding PLINY employs it in all its freedom. THEOPHRASTUS wrote when a little was known, and they who followed him for many ages, were very negligent on the ſubject: it is poſſible they may have founded groſs errors on their ſlight notice of his diſtinctions; but juſtice to his memory requires of us to add, they did not find them in his writings.

PERIOD THE SECOND.

The State of the SCIENCE during the Government of the ROMANS.

CHAP. III.

The BOTANY of DIOSCORIDES.

HIPPOCRATES ſpoke of Plants as a Phyſician, and THEOPHRASTUS conſidered them as a Philoſopher: DIOSCORIDES united the two ſubjects; and to ſerve farther the great purpoſe of utility, he added to what they had written, a great deal from his own experience: an author leſs original than either, but more generally uſeful; born, perhaps, with an inferior genius, but indefatigable and honeſt. To the five hundred Plants of THEOPHRASTUS, he added more than ninety: ſo that in his time the account ſtood at about ſix hundred.

ALL theſe were uſed in medicine, or in the œconomy of ordinary affairs: for the ancients of this period conſidered them only as worthy notice for that reaſon. The ſpirit of a philoſophic enquiry into their nature, which ſeems to have been born with THEOPHRASTUS, died alſo with him. Aſſiduous obſervation formed the character of DIOSCORIDES; but this was more directed to the qualities and virtues of Plants, than to their outward parts, or their internal conſtruction. For tho' he has endeavoured to deſcribe moſt of thoſe whoſe uſes he relates, he has ſeldom done it perfectly. GALEN taught the world to look on DIOSCORIDES with reverence, when he claimed only reſpect; and tho' he deſerves much praiſe, to give him more.

DIOSCORIDES lived long after THEOPHRASTUS; and there are ſome who place him later than PLINY; but this, tho' countenanced by many great names,

names, is plainly an error. PLINY, who was too much obliged to DIOSCORIDES, has no where named that author: for the ancients were leſs brutal than the moderns upon this occaſion. Our authors when they plunder another, attempt alſo to deſtroy his character, that none may ſee their original: they only ſtudy'd to conceal the obligation: a practice printing has now made impoſſible. We owe DIOSCORIDES this juſtice: for tho' he was very far inferior to THEOPHRASTUS, he yet deſerves a higher rank than PLINY. It may be proved that he was really the earlier; tho' the ſame evidence will ſhew, that he preceded the other but a little in point of time. One inſtance may ſerve as a thouſand. Where PLINY names the HÆMATITE and SCHISTUS, he tranſlates the paſſage verbally, tho', perhaps, not happily, from the writings of DIOSCORIDES: he takes from this author exactly not only the deſcription of thoſe minerals, but their virtues; and even the peculiar fluid wherein to mix them up for uſe: this is woman's milk. When PLINY has given this account, he adds theſe remarkable words: This is the opinion of thoſe who have wrote lateſt on the ſubject. We ſee, by comparing the two authors, that it is diſtinctly and exactly the opinion of DIOSCORIDES, and plainly he was one of the late writers whom PLINY quotes, tho' he does not add his name. We know PLINY wrote under VESPASIAN, and this may fix the time of DIOSCORIDES: he, being a little earlier, muſt have written about three hundred and ſeventy years after THEOPHRASTUS.

TRACING the Hiſtory of Botany, we thus find a period of near four hundred years in which no advance whatſoever had been made in the ſcience: for DIOSCORIDES ſays nothing of the philoſophy of Plants which was not known to THEOPHRASTUS. Every thing appears to have been darkneſs before that writer; and all neglect and indolence during ſo many ages after him. The Science of Botany began with him, and in a manner ended where it began. The ſucceeding Greeks appear not to have regarded his diſcoveries, or even to have preſerved with any accuracy, the very names by which he and their other predeceſſors called the ſeveral objects. In this long period between THEOPHRASTUS and DIOSCORIDES, only one hundred Plants were added to the ſtores of knowledge; and theſe, as will appear by that laſt author, were but ill known, and careleſsly diſtinguiſhed.

DIOSCORIDES found Botany little regarded, the philoſophic knowledge of earlier times neglected, and the uſes of a few known Plants only ſtudied. He conformed to the cuſtom of an indolent age, whoſe attention he might, if he had pleaſed, have extended to this other path; and what he has

has written, is regardleſs of ſcience, and eſtabliſhed upon the ſole baſis of utility. Even his arrangement of the ſubjects, is made on this foundation. He conſiders Herbs as Medicines; no otherwiſe: and has mixed the accounts of various kinds together, as he found direction in their common virtues. Thus defective is DIOSCORIDES as a Botaniſt; but as a Phyſician he is highly valuable.

HE conſiders the uſe of Medicines as directed to two purpoſes; the preſervation of health; and its recovery, when aſſaulted and impaired by diſeaſes. He ſuppoſes aromaticks to be the greateſt preſervatives, and firſt treats of them; arranging them all together. This is his original purpoſe; but he has not neglected the conſideration of their forms entirely. Uſually Plants of the ſame natural claſs, have the ſame virtue: therefore they are in general united by a double band: but when two Plants are alike in qualities, and unlike in form, DIOSCORIDES, giving the reſemblance of virtue the firſt place, keeps them together. His writings, therefore, were more adapted to inſtruct the Phyſician than to form or to improve the Botaniſt: and ſuch he intended them. This has its fair excuſe, when we conſider the nature and genius of his work: but there is one compliance with vulgar cuſtom which he has made, and which is leſs pardonable. If the common phraſe of the people called two diſtinct Plants, which had no reſemblance, either in form or virtue, by the ſame name, he has alſo kept them together; forgetful that an author of his rank ſhould have improved the public taſte, and not have ſoothed it in theſe miſchievous errors. He ſeems to have paid ſome regard to the eſtabliſhed diſtinction of Vegetables into Trees, Shrubs, and Herbs; a natural, tho' incorrect, diſtinction, which obtained in and before the time of THEOPHRASTUS; but this, like all other diſtinctions of form, he has made ſubſervient to the agreement of Plants in their qualities: neither has he concerned himſelf about any arrangement or diſtinction according to their parts or forms.

DIOSCORIDES has had the fortune to be named among the Fathers of the Science of Botany; but it is certain he did abſolutely nothing toward its advancement. The knowledge of Medicine in his time, owed to him great things; but the ſcience of Botany not the leaſt improvement. It appears to have had one, and but one, great parent, THEOPHRASTUS. The writings of that author were open to DIOSCORIDES; but his plan did not require that he ſhould uſe them: nor did his genius lead toward thoſe reſearches, into which the other had opened a plain tho' utterly neglected path. As to the knowledge of particular Plants, it is thought the world owes much to DIOSCORIDES, becauſe he has given longer deſcriptions than the elder Greek;

Greek; but more of this appears than is real: the deſcriptions of THEOPHRASTUS, tho' very ſhort, are diſtinct, and expreſſive: thoſe of DIOSCORIDES, tho' they conſiſt of many words, and promiſe great diſtinction, yet are perplexed in the expreſſion, and often confuſed with circumſtances that cannot be reconciled to the reſt of the account. It may be proper to produce one inſtance. In his hiſtory of the Plant φυ, he gives a deſcription containing many articles, and which, tho' not altogether free from confuſion, yet, in the capital points, agrees ſo perfectly with our GARDEN VALERIAN, that it appears evident this ſpecies was meant; till we come to the laſt ſentence, in which he ſays, its Flower is like that of the NARCISSUS, but larger, and more delicate. What ſhould we think of a Valerian with Flowers like Daffodills, but as a creature of the author's fancy? A monſter not to be produced by nature! Yet it is certain, this celebrated Greek has raiſed an Herb, whoſe Root, and Stalk, and Leaves are true Valerian; and hung upon it theſe, as it would appear from the expreſſion, Enormous and Prepoſterous Flowers. It is plain, that DIOSCORIDES knew the Daffodill, and knew it by the name ναρκισσος, Narciſſus; for he has deſcribed it carefully, in the ſame work: diſtinguiſhing the two peculiar kinds, that with the yellow, and that with the red inner circle. But the difficulty may be explained. ναρκισσος was the name of Daffodill in DIOSCORIDES's time; but it had been early given to another, and that a very different Plant; one that has ſo much of Valerian in the Flower, that it is called to this time RED VALERIAN. The name ναρκισσος ſtill continued to be uſed for that Plant, as well as for the Daffodill, when this author wrote; and it is not a raſh thought, that this Plant, and not the Daffodill, is what he meant here; and was alſo the Narciſſus of the Roman Poets.

VIRGIL may have meant this Red Valerian, in all the places where he has named Narciſſus: and he certainly does in many of them. The Narciſſo Floreat Alnus, in the Eighth Eclogue, may mean any Flower; for there is no character or deſcriptive mark annexed to the name there; and in the ſecond, it is mentioned as indiſtinctly. But there are other paſſages where ſomething more is ſaid; and all agreeing not with the DAFFODILL, but RED VALERIAN. When in the fourth Georgick, he names the Tears of the NARCISSUS, and the tough and viſcous juice of its rind;

NARCISSI LACRYMAM ET LENTUM DE CORTICE GLUTEN;

and employs the bees in gathering it for the foundation of their combs; it is probable, he means RED VALERIAN, of which bees are very fond, and

and in the rind of which, toward the baſes of the Flowers, there is a very tough juice: for the Daffodill is not of the number of their favourite Herbs. The *Purpureus Narciſſus* of the fifth Eclogue alſo, is more likely to mean the Flower of this Plant, which is entirely purple, than that of the Purple circled Daffodill, the principal part of which is white: and finally, when in the fourth Georgick he adds, the time of the Narciſſus blowing, and a deſcriptive mark of its tufted Flowers,

SERA COMANTEM NARCISSUM,

it is not probable he meant the Daffodill; becauſe tho' there are late flowering ſpecies, the ancients celebrated only thoſe of Spring: nor is it poſſible he ſhould give the epithet COMANTEM to any NARCISSUS, except the Red Valerian. The Romans expreſſed by COMA, the Tufted Summit of a Plant, formed of numerous little Flowers, and reſembling, in ſome degree, a head of hair: this agrees with the Red Valerian, but is wholly unapplicable to the Daffodill. Columella, in his book of Gardens, is yet more diſtinct, he calls the Flowers of the Narciſſus,

NARCISSI COMAS.

Alluding plainly to their Slenderneſs, and Number on the Stalk, which even in the Many-flowered Daffodills is ſmall, but in the Red Valerian very great. It has been proved abundantly, that what the Latins meant by COMA, ſpeaking of Plants, was a complex Tuft, made of innumerable ſmall Flowers. They called the Panicle or Tuft of the Reed firſt by this name; and afterwards whatever was formed like it; whence afterwards the Poets applied it figuratively to the innumerable Leaves which formed the buſhy heads of Trees. The ſlenderneſs and length of the RED VALERIAN Flowers agree happily with the idea of hairs; but there is nothing in the Daffodill that bears the leaſt alluſion to them.

UPON the whole, there is the greateſt probability, that the ancients gave the name Narciſſus both to the Daffodill and Red Valerian; as we even yet give the ſame name, in many caſes, to two Plants abſolutely different. It is impoſſible DIOSCORIDES could compare the Flowers of Valerian to the firſt of theſe, the Daffodill: but none can wonder he ſhould liken them to thoſe of the latter; which, tho' it was plainly known to the ancients, has no other name among them: late writers have made it a Valerian, from the reſemblance of its Flowers to thoſe of this very Plant.

THIS

THIS reconciles the difficulty; for the Flowers of Wild Valerian are not only like thoſe of this Narciſſus, but their difference is exactly what DIOSCORIDES expreſſes; they are larger at the opening, and their colour is not a bright red as in thoſe; but a whitiſh Purple. If this be the caſe, and this the Plant to which the Valerian Flowers are compared by DIOSCORIDES, tho' the reſemblance be ſufficient to juſtify the compariſon, the author is inexcuſable in referring to an Herb under the name Narciſſus, which himſelf has no where mentioned or deſcribed; when he had treated at large of another Plant, the DAFFODILL, which is not the thing here meant under the name Narciſſus: it could be only thought that he referred to the Plant of which himſelf had treated by this name, when he uſed it in the preſent inſtance; but it appears too plainly, that it was to the Narciſſus of other and earlier authors he reſembled Valerian, and not to the Plant himſelf had deſcribed under that term. From this, and other circumſtances too like this, it appears a doubt to me, whether DIOSCORIDES underſtood, or had ever ſtudied Botany. The nature of his undertaking led him to ſpeak of Plants; and he did well and wiſely to annex deſcriptions; but to aſcertain their virtues was his great aim: and it is not improbable he collected from others thoſe accounts which he has given us of their forms, and colours. I would not depreciate a venerable name; nor has this obſervation, properly, any ſuch tendency. DIOSCORIDES propoſed himſelf to the world as a phyſician, and he appears to have been a very great one; but he plainly was no Botaniſt.

THEREFORE we ſtill ſee the long period of the neglect of Botany continued. Four centuries had paſſed from THEOPHRASTUS to the time of DIOSCORIDES, and no advance had been made: even this great man, whoſe extenſive undertaking led him to treat of Plants, yet conſidering them only as medicines, added but a few to the Objects of the Science; and nothing to its progreſs in Philoſophy.

CHAP. IV.

The BOTANY of PLINY.

AS we know nothing of Botany as a Science before THEOPHRASTUS, the Grecian empire gave the world no author after him: the ſubject ſeems to have ſlept among the poliſhed world from that time to the period of the Roman Pompey. His victory over Mithridates, gave it a

new birth among the world of letters. What that celebrated prince knew of Plants, and of their virtues, appear'd of ſo much importance to the wiſe Romans, that the Conqueror ordered the writings of Mithridates to be tranſlated by Lenæus; and men applied, in ſome degree, to the ſtudy: yet they made ſmall advances. CATO, and VALGIUS, and VARRO, are the principal names celebrated on this account: but a few obſervations on the virtues and œconomical uſes of a very ſmall number of Herbs, was all the world obtained from their reſearches. ANTONIUS MUSA and EUPHORBUS, born, as it ſhould ſeem, to bring the Grecian medic arts to Rome, grew famous about the ſame time. The former of theſe is celebrated for a treatiſe on the Plant Vetonica, the firſt of the Botanical Monographi. We have the name alſo of an ÆMILIUS MACER, of whom we read in Ovid, and who wrote in verſe of Plants; but by all we know, this alſo was limited to their virtues; a poem not botanic but medicinal. BASSUS and NIGER wrote in Greek of Plants, ſome ſmall time before DIOSCORIDES, but if that author's account of them be true, if the one was prolix and idle in his manner, an ignorant and injudicious compiler; and the other took Aloe to be a mineral; we need not much lament the loſs of what they wrote. Theſe COLUMELLA followed, eminent for his account of the ancient Huſbandry; but what he has written of the Field Plants, or Garden Flowers, adds nothing to the Botanic Science. Of DIOSCORIDES we have ſpoken; and a ſmall period after him came PLINY.

THIS name, treated too often with an implicit reverence, Truth, and a ſtrict enquiry into the Hiſtory of Botany, would oblige Candour itſelf a little to prophane. PLINY muſt not be ranked among the original writers; nor can it be ſaid this ſcience owed to him any new light, or the leaſt advance toward improvement. His merit is that of a Collector only; but as he gathered from the writings of authors now loſt, his work is highly valuable. Perhaps the botanical part has leſs worth than moſt of the others; but this, if uſed with caution, is not without its merit. As he collected generally, all that he has put down is not of equal authenticity. The works of THEOPHRASTUS and of DIOSCORIDES plainly were before him; and he has taken from them largely: other ſtrange matter has its place among what he has thus collected; and probably we owe it to the Baſſus and the Niger named before, or to one or other of thoſe authors, whom, tho' not much to their honour, DIOSCORIDES quotes as having written a little before him, JOLAS, and TARENTINUS NICERATUS, another NIGER, and a DIODOTUS condemned to eternal memory, by their imperfections. All theſe were before PLINY; therefore he might uſe their writings, and by a great

deal of his matter, and their characters, it is probable he did; therefore tho' his great work is an epitome, as it were, of the Grecian and early Roman knowledge, it must be used with extreme caution, or it will lead the reader into strange errors. It is evident, he understood no Botany; nor had any knowledge of the Plants concerning which we find so many chapters in his work; he owed principally to the Greek writers what he has said of them, and unhappily he was but a very indifferent master of their language. This appears plainly, because we have the originals in many instances, and can judge of his translations. These are the imperfections of PLINY; but guarding against the errors to which these might seem to lead, we find a great deal of knowledge in his work, not to be meet with in the others.

FROM THEOPHRASTUS to DIOSCORIDES, tho' a period of between three and four centuries, BOTANY had been so little regarded, that not altogether a hundred Plants were added to the original Catalogue: but the account wears a new face, from DIOSCORIDES to the time of PLINY; and it is to that laborious Greek we probably are to attribute the advantage. His writings seem to have raised a spirit of enquiry in the curious world, upon a subject which had slept so long: And the period between him and PLINY, which cannot reasonably be accounted more than thirty years, added at least four hundred Plants. PLINY names, and in some degree describes, more than a thousand species. The subject is started in his twelfth book, and is continued to the twenty-seventh. It makes within a few pages half his vast work.

PLINY sets out with a bold and singular principle, that Vegetables have a soul. What the more reserved THEOPHRASTUS called the PRINCIPLE OF LIFE in Plants, the Roman dignifies with that superior name; distinguishing it, however, from the soul of animals, as of a subordinate kind. We must not wonder at this thought in PLINY, for Soul with him meant less than we are taught to understand of it: he considers Soul as the Seat of Life; and tho' he had been taught by that HIPPARCHUS, whom all ages celebrate, to account the Soul of Man a part of the Heavenly Essence, yet he despises those who held, as he expresses it, the vain and idle thought, that it existed after death. We know hence what he means, by that he calls the Soul of Plants, a subtle something upon which their growth depends; and which perishing with them, there ceases utterly. This is all the addition PLINY made, if it may be called an addition, to the Philosophy of Plants.

IN his arrangement of the ſubjects, he adopts the received diviſion of Vegetables, into Trees, Shrubs, and Plants, beginning with the Trees; but he is very vague in his ſubordinate diſtinctions. As there is nothing philoſophic in his manner, the matter on which he ſeems to beſtow moſt attention, is rather hiſtorical than botanic: the periods when foreign Trees were firſt introduced into Italy, and the inventors, or times of the invention, of cutting them into various forms for gardens, are his firſt conſiderations: from theſe he enters on the foreign Trees which produce Drugs and Spices; but he acquits himſelf in this part with ſo little knowledge, that he firſt ſays, the Pepper grows on a Tree like the Juniper; and afterwards, in the ſame chapter, that it is a ſmall Shrub like the Myrtle: quoting their accounts who, as he ſays, had raiſed it at that time in Italy. Of Sugar he knew ſomewhat more; and we find by him, that the Romans had it from INDIA and ARABIA; he deſcribes it as a honey-like concretion from a Reed. In the reſt of the twelfth book, there is a great deal of information, concerning the early Hiſtory of Drugs, but intermixed with abundance of abſurdity and error. He only can gather knowledge from it, who firſt very well underſtands the ſubject.

HIS next book, in its firſt chapters, treats profeſſedly of Unguents; and is hiſtorical, but not correct. After theſe the Palm, and many other trees, are treated as in the preceding part, ſo wildly, that Paper coming into conſideration, leads him to an hiſtory of the books of Numa. The fourteenth book contains his account of Fruit Trees. He introduces this with ſome very whimſical cenſures upon VIRGIL, whom he reckons happy to have eſcaped thoſe of the world. A great deal may be learned from what he has recorded of the old management of the Vine, and the various kinds of Wine; tho' we neglect the Arabian kind, which made barren women fruitful, or that Trærænian liquor which rendered the men impotent. The fifteenth book purſues the ſubject of the former; treating of other Fruit Trees: but that ſucceeding, is leſs regular. The honorary uſe of Leaves in Crowns and Garlands, has its place there; and after this, many of the Fruit Trees are treated of diſtinctly, and with great erudition. There are in this book alſo ſome approaches towards the Vegetable Philoſophy. We ſee whence this part was collected; but it is not a ſubject on which PLINY ſucceeds happily. The next treats of the Culture of Trees; and of Manures, and the general Dreſſing of Land. The directions of THEOPHRASTUS are transferred hither: and a great deal is added to them. The articles of Graſting, and the reſt of the Gardener's arts, are not ſet down in all parts ſo clearly as might have been wiſhed; but we find the Romans

Romans knew them thoroughly. There are paſſages, in this author, on the ſubject, from which we may even now gather much inſtruction. The Vine alſo is here conſidered farther than in the former articles, and with a great deal of knowledge. The eighteenth, nineteenth, and twentieth books, contain the practice of the Greeks and Romans in common Gardening and Agriculture: and in the end of the laſt of theſe there is introduced alſo ſomething medicinal. The ſubject of his next book is of Flowers; and as they yield honey, the management of Bees is introduced among them. The twenty ſecond treats of a mixed multitude of Herbs, and a ſecond time of Honey; and the two next, give the medicinal virtues of many Trees and Plants, chiefly from DIOSCORIDES. The twenty fifth book ſets out with what would have been a more regular Exordium for the whole, a kind of Hiſtory of Botany: the reſt of this, as alſo the ſucceeding Book, give the medicinal virtues of ſeveral more Plants, with ſome farther ſlight account of them. Finally, the laſt, or twenty ſeventh, tho' leſs methodical than all the reſt, is full of uſeful matter; but this is ſtrangely mixed with impertinence, and perplexed with error. Whatever the author's collections contained, that could not eaſily be brought into the other books, ſeems to be thrown together, without order, in this: and ſo concludes his Botany. By this ſketch of the writings of PLINY on the ſubject of Plants, it will appear that they conſiſt of a diſorderly, and ill ranged collection of various things, compiled from different authors: and it will be found, theſe too often contradicted one another. PLINY, who put down all, is therefore ſaid to have been ſometimes at variance with himſelf; probably he never gave the laſt finiſhing to his work: we know an unexpected death ſurprized him. But while we regret the imperfections and confuſion of this vaſt compilation, which he has left behind him, we cannot but allow its uſe and value.

THE Fate of Botany in this period reſembles that in the preceding: Medicine was improved by the addition of a great number of Drugs; but the ſcience, from whoſe ſtores theſe were furniſhed, languiſhed. The Hiſtory of Botanical Writers, is a common ſubject: GESNER is eminent in it, and FUECHSIUS, from whom the careful TOURNEFORT has compiled his juſt and judicious account, deſerves more, perhaps, of the world, as an Hiſtorian than a Botaniſt. One could not wiſh to follow better leaders. But the immediate ſubject here, is not a hiſtory of the authors, but of the ſcience: the two conſiderations are intimately connected: and this moſt eſſential part has been the leaſt regarded. It can only be traced thus in their works.

CHAP.

CHAP. V.

Of the STATE of BOTANY, from PLINY to the Time of the ARABIANS.

THE Romans had been waked to a ſenſe of the importance of a knowledge of Plants by DIOSCORIDES; tho' the Greeks, celebrated as they were in all other arts, had not caught from their own THEOPHRASTUS the ſacred fire of ſcience. That curious ſubject, the Philoſophy of Plants, had lain neglected all this period, and was to lie in that dead ſtate much longer; but from the time of PLINY, Plants, ſo far as they concerned medicine, or the uſeful arts, became greatly regarded. RUFUS wrote of them in this light under TRAJAN; and after him PALLADIUS became eminent in the whole art of Agriculture: ſo far as Plants were concerned within the limits of this ſubject, he treated of them, but no farther. The Romans extended the uſes of Herbs, but the ſcience of Botany was more known in early Greece. About a hundred and fifty years after CHRIST, GALEN appeared upon the theatre of the world; a Greek, as DIOSCORIDES, tho' under the Roman empire. He has been celebrated highly; and tho,' perhaps, he deſerves leſs than ſome have ſaid, his merit, the value of his writings, is conſiderable. An attention to the hiſtory of drugs, poſſeſſed him even to enthuſiaſm: not content with what he ſaw of them, or what he heard or read concerning their hiſtory, he viſited the places whence they came; Lemnos, for its earth; and Paleſtine, to ſee the Opobalſamum.

PLANTS, which make ſo conſiderable a part of the Materia Medica, ſhared his attention in a juſt proportion; but ſtill it was as a Phyſician that he conſidered them; not as a Botaniſt. He ſeems to have been acquainted with about five hundred. Their virtues were the object of his ſearch: and theſe he has characterized according to certain degrees of their imagined general qualities, hot, cold, moiſt, dry, and the like.

GALEN does not appear to have attended to the improvement of Botany, or if he had, the taſk had been too great for him. The ſcience, which had roſe with THEOPHRASTUS, continued to decline, and was now ſinking faſt into barbariſm. A confuſion of names, and ill conceived deſcriptions, obſcured the little light which had once ſhone upon the ſubject; and all tended faſt to general ignorance. PLINY had condemned the uſe of

of Figures of Plants; and GALEN laughs at thoſe who ſhould think to learn a knowledge of them from deſcriptions. Such as wiſhed to know their forms, were told there was no way but by their being ſhewn to them: and thus Botany, even by the authority of thoſe who had moſt credit with the world, became reduced, from a regular and noble ſcience, to a pitiful and precarious art; which men were to learn by rote from one another. This, tho' they did not ſeem to ſee ſo much who propoſed it, ſtruck at the root even of its utility: for it was in vain, the ancients informed men of the virtues of Plants, if their names were changed. This GALEN ſhould have foreſeen muſt happen, when the knowledge of them was taught in ſo precarious a manner; and it had already happened: for GALEN did not know many of the Plants of THEOPHRASTUS; nor did theſe verbal inſtructors, ſuch as they were, well underſtand one another. This at once ſhews the miſery of a neglect of ſcience; and places in a light of juſt regard, the modern fixed and eternally eſtabliſhed diſtinctions.

ORIBASIUS followed GALEN; his countryman, and long his diſciple: we find in him an inſtance of the unhappy truth juſt named; and we find little more. GALEN knew ſcarce half the Plants of PLINY, and ORIBASIUS did not know thoſe of GALEN. Error is always the Parent of more error. All that is uſeful in this author, he had from GALEN; but he has debaſed the ſtudy with puerile imaginations.

AETIUS followed, or was cotemporary rather with the latter years of ORIBASIUS, another Aſiatic Greek, as he and GALEN were. He was a mere compiler, and a very indifferent one, ſo far as Botany, our ſubject, is concerned. TRALLIAN came next; and he diſcloſed a ſpirit more free and fit for ſcience. He ſtudied things themſelves, not the deſcriptions of them; and he often diſſents from GALEN, where truth demanded it, tho' he allows that author the high epithet of Divine. It was happy for the age, that ſuch a man aroſe as a Phyſician; and it had been well for Botany, if a genius ſo much of the original ſtamp, had directed his thoughts more that way; but it was then, and it continued long after, an unreputed ſcience.

ANOTHER Aſiatic, ÆGINETA, aroſe a little after; a phyſician and a ſcholar, who muſt be named, becauſe he treated of Plants, but not diſtinguiſhed by the title of Botaniſt. He made an abridgment of the works of GALEN and his firſt followers. In this work he could not omit to name many Plants; but he added nothing to the ſtore.

SUCH

SUCH is the History of Botany during the empire of the Romans. The rudiments of the science were imported from Old Greece; but tho' Greeks wrote afterward, these were very little extended.

PERIOD THE THIRD.

The State of BOTANY among the ARABIANS.

CHAP. VI.

The Revival of the SCIENCE under the CALIPHS.

THAT knowledge of the Vegetable World, which Egypt learned from the Chaldæans, and which being received in early Greece, was there exalted to a science, declined during the Roman empire, and died with it. That people had neglected it extremely; and tho' many Greeks, celebrated for their knowledge, wrote under their government, the best they did was copying their masters. We now must view the science in another Æra. After a period of more than three hundred years, wherein this and all other learned arts lay utterly uncultivated, Botany revived among the Arabs.

IN the year of CHRIST 754, the second Caliph, AL MANSUR, a philosopher and scholar, fired with the praise bestowed upon the Grecian knowledge, gave order that the most valuable of the writings of that people should be translated into his language. Something was done: but the great path he opened lay untrodden after him, till the seventh Caliph, AL MAMUNEM. This patron of the useful arts, applied with a new spirit to what AL MANSUR had so well begun: he sought from Greece, by embassies, whatever writings were most respected in their philosophy; and science, in the year 832, took root among his people. He who had thus obtained the Grecian writings, invited next, by his liberalities, all the learned to join in an undertaking of translating them: peculiar names among these people, now grew eminent in medicine and in philosophy: each had his destined part in the great work; and the Caliph himself,

ſelf, from time to time, inſpected their progreſs, and joined in their reſearches.

BOTANY now put on a better face; and promiſed more in this new region than any where, excepting in her native ſoil. Ages had paſſed ſince their days whoſe writings now became once more the baſis of all knowledge; and much had been done, and much known, tho' rudely and irregularly hitherto, among the Arabians themſelves. This they added to the ſtores they drew from the old Greece; and they became adopters and improvers of Botanic Knowledge: not content to be what the late Greeks had been, mere ſlaves and copyiſts of their predeceſſors. Theſe Arabs were an intermediate race between the Greek and Roman ſtates, and ours; and it is, indeed, to them Europe owes, much more than to any others, its preſent knowledge of medicine.

SERAPIO, the firſt in point of time, perhaps alſo the firſt in genius, among the Arabs, lived in the days of that ſecond Caliph who undertook the introduction of the Grecian arts among his people: perhaps it is to this writer we owe the attention which that Caliph ſhewed to them. He collected whatever he could find relating to medicine, among the authors either of Greece or his country, reduced all to order, and enriched the compilation with much knowledge of his own. He knew ſeveral of the Greek Plants well; and aſcertaining the before vague and uncertain meaning of their names, made thus the firſt advance among the Arabs, toward the improvement of Botanic Knowledge.

RAZIS appears conſiderable after SERAPIO, and he had opportunities to have done much more than the other. SERAPIO lived before and during the time of the firſt attempt to introduce the Grecian learning into his country; but RAZIS followed after almoſt two centuries, within which period that ſeventh Caliph had appeared, who perfected the work the ſecond had begun; and when all the Grecian knowledge had been almoſt a hundred years familiar in his country. That part of the Materia Medica which is obtained from Plants, led RAZIS to ſpeak upon this ſubject; but it makes only a ſmall article of his works; and all we learn from it is, that tho' Botany had continued advancing, rather than declining, from SERAPIO's time to his, it yet had received but little addition.

DIOSCORIDES and GALEN were the oracles of the ſucceeding AVICENNA; but he added alſo ſomething from the improvements of his countrymen; and ſome portion of knowledge, tho' ſtill leſs, from his own. He ſeems to have known many Plants; and it muſt not be denied, that ſomething is added to the Botany of his country, tho' it be not much, in

his writings. ACTUARIUS appeared ſoon after, an author of a new kind: a tranſlator of the Arabian knowledge into its fundamental Greek. Such changes ſcience knows, and ſuch ſtrange journeys. The character of ACTUARIUS is formed of learning, diligence, and modeſty. He ſelected from the earlier Greeks, as well as the Arabians, and from the whole formed a judicious body of medicine; in which the Materia Medica, and Plants, as a part of it, have their place: but if he has added any thing on this head, it is leſs than his predeceſſors. MESUE, a prince, next applied himſelf to the ſtudy of medicine among this people. He lived about the middle of the twelfth century; and to a very perfect knowledge of the former writers, added many things, from an extenſive and well conſidered experience. AVERRHOES was cotemporary with MESUE; and, like the reſt, he compiled with care, and added his own knowledge. GALEN was his oracle concerning the virtues of Plants; but he ſeems alſo to have known them from his own obſervation.

EBENBITAR, a more diſtinguiſhed name than all the reſt, followed theſe in the beginning of the thirteenth century; and cloſed the Arabian catalogue. He ſtudied the whole Materia Medica, but was diſtinguiſhed moſt for Botany; and he not only increaſed the knowledge of it greatly, but gave the ſcience itſelf a new and more reſpected eſtimation. He travelled, as GALEN had done, to obtain perfect knowledge; and he wrote down to large his obſervations and diſcoveries. As the Botanic part of the Materia Medica, had employed his greateſt attention, and he had ſeen the Plants themſelves, in long and repeated journies, and as he ſpeaks of them from what he ſaw, his writings have a merit beyond thoſe of all his countrymen. He at the ſame time extended and aſcertained the objects of the ſcience: from him may be known the Plants, not of the Arabians only, but many of thoſe of the old Greeks: which we trace elſewhere in vain.

PERIOD

PERIOD THE FOURTH.

The State of BOTANY during the BARBAROUS AGES.

CHAP. VII.

The DECLINE of BOTANY to an abſolute NEGLECT.

WITH EBENBITAR died the Arabian knowledge; and Barbariſm overſpread the world: this and the other ſciences lay for a long time neglected. This Period takes its date from the latter end of the twelfth century; and it continued till the time but little earlier than our lateſt anceſtors. Books were no longer written on any part of Medicine; and the entire art now, like Botany in a ſomewhat earlier time, depending on tradition, gradually decayed. But it was fated, that this ſcience, as it had its origin in Greece, ſhould yet owe alſo to the Greeks of this period a faint attempt towards its reſtoration. The firſt Botanic writer who appears after the juſt celebrated Arabians, is MYREPSUS. He wrote when every thing was yet obſcured in clouds of ignorance, and appears himſelf with difficulty, emerging from the general barbariſm. His language is inelegant, and full of ſtrange terms; and his knowledge of Plants is extremely confuſed, not to ſay very imperfect. This dawn of a reviving ſcience was afterwards clouded over, and a more perfect neglect followed. The next writer of theſe Greeks, NICOLAUS PRÆPOSITUS, is much inferior in all reſpects to MYREPSUS; he is a crude collector, with plainly nothing of his own. The next in order of time to him is HILDEGARDIS, and he ſinks yet below PRÆPOSITUS, degrading the little knowledge he appears to have collected, by puerilities, and ſuperſtitious folly. Soon after this ſlight author appeared PLATEARIUS, with ſomething more of ſtudy and deſign. This writer opened the fourteenth century; and gave ſome promiſe of a reviving literature. His diſtinction of the Vegetable part of the Materia Medica, is upon the received plan of Tree, Shrub, and Plant, and he writes with ſome knowledge of the ſubjects: poor in compariſon with thoſe

of a much earlier date; but ſuperior by many degrees to his immediate predeceſſors. Twenty years after PLATEARIUS, SYLVATICUS publiſhed a great work on medicine; but he had undertaken more than he could perform; and with a deſign of explaining terms, he rendered them more obſcure. SYLVATICUS lived about the year 1320, and he appears to have known little of Plants. The ſame period furniſhed three other writers ſcarce better than the laſt: theſe were VILLA NOVA, DONDIS, and PETER CRESCENTIENSIS. This latter wrote expreſsly upon Plants thro' a great part of his treatiſe, but with a degree of ignorance ſcarce to be equalled. The miſerable ſtate of literature continued; yet men wrote, and wrote of Plants. More than a hundred years after theſe ſtrange authors, CUBA publiſhed his HORTUS SANITATIS, in 1486; and he was followed by THERTONA, DE BOSCO and SUARDUS. The laſt of theſe wrote his Antidotarium in 1526: the others their ſeveral pieces ſomewhat earlier: all ſpoke of Plants, but with moſt perfect ignorance; nor had they language worthy even of their poor conceptions. The writers of an earlier time, to whom they referred, were ſome of the lateſt Arabians: as to the Greeks, they did not ſo much as properly know their names. They ſhew they could not ſpell HIPPOCRATES.

PERIOD THE FIFTH.

The STATE of BOTANY at the New DAWN of LITERATURE.

THUS, for four centuries, Barbariſm overſpread the world; from the days of EBENBITAR, the laſt of the Arabians, to the latter end of the fifteenth century. Then dawned upon the world the firſt light of a revival of letters: and Botany was early regarded by thoſe who ſhine moſt conſpicuous in that undertaking. It is ſingular, that in this ſcience we owe all to Greece: there the firſt rudiments of Botany were eſtabliſhed; and that GAZA was a Greek, who in a manner began the reſtoration of learning at this period, by a tranſlation, firſt of ARISTOTLE, and then of THEOPHRASTUS, into Latin. This led the way; and the father of the ſcience had afterwards ſo many commentators, that Botany was plainly a much eſteemed ſcience. The works of this great author, as they had been the original, became now the ſecond baſis of all Botany; and SCALIGER and

and CONSTANTINE, HEINSIUS and BODÆUS A STAPEL, laboured to explain his meaning. There wanted, and there yet wants, a Botanical Tranſlator, to ſhew us all his merit, and to give new improvement to the ſcience. HERMOLAUS BARBARUS followed: no more indeed than a Commentator, but one of a ſuperior excellence; and theſe were the men the age then wanted. It was not likely ſcience ſhould ſhew her long obſcured head at once in an original form: the rudiments were firſt to be traced in theſe early maſters; and HERMOLAUS explained excellently, the accounts of DIOSCORIDES, relating to the Botanical part of the Materia Medica. The beginning of the ſixteenth century gave the world RUELLIUS, a Botaniſt and a Scholar; who following theſe with a greater degree of knowledge, and ſcarce leſs learning, eſtabliſhed finally the doctrines which they had juſt begun to raiſe. Botany began with him to wear the face of a new ſcience. Others had ſtudied names, and words; RUELLIUS things: he was ſkilled in Plants, and for the time very conſiderably: he therefore was able to execute what others had attempted vainly; and he told the world what were the Plants then known, which anſwered to the names in DIOSCORIDES and THEOPHRASTUS. From him firſt, ſince this revival of letters, men knew what were the Plants mentioned by the ancients; and he is the firſt who for very many ages had done any thing towards the advancement of the ſcience of Botany.

THIS opened a path into which many followed; and from RUELLIUS we may juſtly date the Æra of Reviving Botany. MARCELLUS VIRGILIUS came next after him, a lover of Botany, tho' of no great knowledge; faithful in his comments on the old Greeks, and happy in the application of much of RUELLIUS's knowledge. In ſome places he has interpreted DIOSCORIDES differently from that author, and always in that caſe unhappily. MONARDUS followed him; and while he added a great deal from his own ſtudies, he did juſtice always to RUELLIUS againſt this inferior, tho' uſeful writer. A number of interpreters now followed; LEONICENUS BRASSAVOLUS, BRUNFELSIUS, RIFFUS, the two CORDUS's, and GOUPYLUS. FUCHSIUS come after theſe, and more than all men turned his mind to original and additional knowledge: the old Botany had been enough ſtudied; and it was time now to look into the book of nature. LONICERUS had ſhewn many errors in the interpreters of PLINY; and BRASSAVOLUS had attempted boldly, tho' with too weak abilities, at ſomething new. BRUNFELSIUS took the ſame path; and tho' he added ſomething, ſucceeded, upon the whole, but unhappily. Theſe, however, all followed the Ruellian courſe; and ſomething, from time to time, was added

added to the ſcience. The firſt CORDUS ſpoke alſo of ſome Plants from his own knowledge; and the ſecond of that name, ſon to this firſt, beſides his comments upon DIOSCORIDES, publiſhed A HISTORY OF PLANTS, with Figures. He was careful in his obſervations, and his deſcriptions are ſcarce otherwiſe imperfect, than from the want of terms, for the diſtinct parts; an imperfection not to be charged upon him, ſo much as on the ſtate of the ſcience in his time.

RIFFUS, who wrote a little before, and AMATUS LUSITANUS, who followed this CORDUS, were raſh and ignorant commentators on the ancients; preſuming to explain what they did not underſtand. LACUNA had more learning, but not much Botany. TRAGUS, who appeared next after theſe, and flouriſhed about the middle of the ſixteenth century, was a proper ſucceſſor of the laſt CORDUS: he ſtudied Vegetables in their own ſtructure, not in books alone. He publiſhed a hiſtory of Plants, with tolerable figures; and he has given great light into the GERMAN FLORA. CORNARIUS lived in the ſame time, and he made ſome, tho' ſlight additions to the ſcience. He is moſt known by a diſpute with FUCHSIUS, too potent an antagoniſt. GOUPYLUS was a ſcholar, and a good commentator; but he added little, tho' he explained much: a uſeful, rather than a great writer. FUCHSIUS a little after publiſhed an excellent account of the German Plants, with a great many good figures: but DIOSCORIDES is too often the author of the deſcriptions; and they are frequently, therefore, unlike the Plants: for the time is not yet come, when the Greek Botany is ſo eaſily reconciled to what we ſee in Europe. This FUCHSIUS wiſhed to find; and therefore often perſuaded himſelf he really found it.

RONDELETIUS, about the ſame time, travelled in the ſame path with advantage. He was happy in an aſſociate, PELLICERIUS, a dignified churchman; to whom thoſe who envied RONDELETIUS, attributed his diſcoveries. He was a Naturaliſt of great diligence, and underſtood very well what had been done before him. PLINY's Plants never were ſo juſtly underſtood as by his means; tho' in the nature of the ſubject, there muſt be great imperfection. About this time alſo, near the middle of the ſixteenth century, England produced a kind of Botaniſt. TURNER's HERBAL was publiſhed in 1551: a work better ſpoken of by foreigners than it deſerves: but its early date gives it ſome claim to notice. MATHIOLUS, celebrated for his laborious commentaries on DIOSCORIDES, flouriſhed a little after theſe. He had great advantages from the many excellent writers who had conſidered that author before him; but he wanted a real knowledge of

of Plants. He has collected boldly, and tranſcribed haſtily, upon this ſubject: ſomething of this he owns; but more is true. MARANTA, and ADAM LONICERUS, are alſo to be added to the Botaniſts of this great period; the firſt knew Plants well, and has explained happily ſome of the obſcure ones of the ancients; the other was too much obliged to TRAGUS.

BOTANY was become ſo reſpected, and ſo faſhionable, at this happy period, that ſome began to imitate thoſe venerable Greeks who undertook the longeſt voyages, in ſearch of Plants; and others, whom their peculiar occaſions called abroad, made this alſo a part of their employment. The new world, AMERICA, was diſcovered; and GARCIAS, and the two ACOSTAS, HERNANDES, and MONARDES, BONTIUS, PISO, and MARCGRAVE, with many more, brought from thence, and from the other remote quarters of the earth, a multitude of new Plants. The ſtores increaſed, new ſpecies were known, and the ſtudy was more cultivated: but yet figures, deſcriptions, hiſtories of the peculiar Plants, were all; and nothing was attempted in the road of Science.

DALESCHAMP appeared about the ſame time with theſe, and ſtudied the Vegetables of France carefully. He undertook a General Hiſtory of Plants; and MOLINÆUS aſſiſting, there appeared, after ſome years, that great work the HISTORIA LUGDUNENSIS: valuable, tho' too full of errors. TABERNAMONTANUS was nearly of the ſame time; a curious obſerver of the forms of Plants, and of their virtues: but he took ſo much from others, that it is hard at this time to ſay what was his own. DODONÆUS had written alſo juſt before this period, adding ſome Plants to the already increaſed number; a writer much obliged to others, but fair in owning it: and from a tranſlation of his works, by Doctor PRIEST, our GERARD put together his Engliſh Herbal. In this, however much he borrowed, he added fourteen Plants to the Botanic Catalogue.

CAMERARIUS was another of the Botaniſts of this period, happy in his intimacies and connections with eminent perſons, who ſtudied the ſame ſubjects. He was attentive alſo himſelf to the living Plants; and the world would have been much indebted to him, if all he wrote, and all he collected, had been publiſhed. SARRACEN, after him, gave new lights into many parts of DIOSCORIDES; a taſk the eaſier, becauſe more Plants were known: but his error, like that of all his predeceſſors, is the attempting too hardily to reconcile the deſcriptions of thoſe old Greeks to the Plants of our Europe. BELLONIUS muſt be added to the long liſt of Botaniſts of the period whereof we now write; an author who ſeems only to have

wanted longer life, to have demanded by his writings immortality: aſſiduous himſelf, and urging others to aſſiduity. What he has written of Plants, ſhews a diſcerning ſpirit, and an enterprizing genius.

IN 1573, RAWWOLF travelled the Eaſt, in ſearch of knowledge; and tho' his obſervations were diſtracted by many other objects, he yet brought in great additions to the ſtore of Botany. GUILANDINUS and PROSPER ALPINUS followed, profeſſors in the Patavian Garden; they added to the increaſe, as well as amended the ſtate of Botany of their time: the latter viſited Egypt in 1580, and brought home many new Plants. The love of the ſtudy now grew univerſal: and the immediately ſucceeding time give birth to ſyſtem, in the breaſt of CÆSALPINUS; from whom we are to date a new Æra in the Botanic Hiſtory.

PERIOD THE SIXTH.

The REVIVAL of the SCIENCE.

CHAP. VIII.

Of the ORIGIN of SYSTEMATICK BOTANY.

THE term BOTANY, has been underſtood as expreſſing the Doctrine of Plants at large, and in all its various lights; but tracing the origin and progreſs of the ſtudy, we ſee it at the ſeveral periods under diſtinct appearances: theſe, however, are all reducible to thoſe general heads, which we may diſtinguiſh by the terms PHILOSOPHICK, HISTORICAL, and SYSTEMATICK BOTANY. Of theſe, the firſt and nobleſt has been the leaſt cultivated: it began, and in a manner ended, with THEOPHRASTUS: its object is the nature of Vegetables as Vegetables, independent of all other conſiderations. To this ſucceeded the HISTORICAL BRANCH; gathering the Names and Numbers of Plants, their Place of Growth, their Virtues, and their œconomic uſes. This was the object of thoſe who ſtudied Herbs from THEOPHRASTUS, to the latter end of the ſixteenth century; when CÆSALPINUS gave origin to the SYSTEMATICK BOTANY. Till his time Plants were arranged, even in thoſe who wrote beſt of them, accord-

ing to the old and irregular diviſion into TREES, SHRUBS, and HERBS; or according to their virtues, to the letters of the alphabet which began their names, or by ſuch other vague and arbitrary methods. Their increaſed number now made it neceſſary they ſhould be better arranged; and this great author ſtruck out that path which has ſince been trod ſo happily, of examining their parts, and deducing thence the characters of Claſſes: arranging in each claſs all thoſe which had the peculiar mark which made its diſtinction. This is the true and only road to certain knowledge; we are happy who ſee it ſo aſſiduouſly followed, and ſo greatly improved; but the praiſe we owe to thoſe who have given the Syſtems of Botany their preſent form, muſt not make us forget his glory to whom they owe their firſt eſtabliſhment.

THE origin of ſyſtematical Diſtribution, was the ſelecting ſome part of a Plant which was obvious and regular in itſelf; and eſtabliſhing a Character upon its Deſcription, to which all others, that had the ſame mark, were referred.

THUS were formed the Characters of Claſſes, firſt; and then the diſtinctive Marks of Genera. Between theſe alſo there came naturally, from leſſer particularities, the Subdiviſions of the Claſs, by Orders. The path once opened, one would have thought, all who had judgment, would have ruſhed into it: but this did not happen. The European Founder of the ſcience was more than a century without one follower. It was evident no other way could aſcertain the objects of the ſtudy; yet this was long rejected.

THE original invention was the choice of ſome one part for the Character: and what part that ſhould be, was left at diſcretion. The great Inventor choſe the Seeds: which he had ſtudied carefully; he arranged Plants according to the ſituation of the Corculum, or Heart of the Seed, and to its place upon the Plant: and upon this baſis he founded the firſt juſt arrangement of Plants.

TRUTH was thus ſhewn; and at length, when the great author's name was almoſt forgotten, others adopted it. None doubted whether CÆSALPINUS had done right in ſelecting ſome part, from which to form a Character; but it became a queſtion whether he had choſen the moſt proper. Hence followed the variety of methods: and the new period became as fruitful in ſyſtematick, as that of about one hundred and thirty years before had been in the hiſtoric writers. Conviction at length appeared upon the face of the deſign; and every Botaniſt perſued it: various parts of Plants, and various collections of parts, were adopted for the Characters

of Claſſes: opinion led ſome, and a deſire of novelty induced others, in their choice of different portions of the Plant. Tho' many bad ſyſtems were thus formed, there alſo appeared ſeveral which had merit; and not the worſt but gave a great deal of new light into the ſtructure of that part on which it was eſtabliſhed.

THE old diſtinctions were no more regarded: the virtues of the Plants, the ſeaſons of their flowering, their place of growth, or the initial letters of their names, were no longer made the objects of arrangement. The early diviſion into Trees, Shrubs, and Plants, indeed, long held its place: and ſtubborn Nature ſo far triumphed over the diſtinctions of arbitrary ſcience: at length LINNÆUS roſe to aboliſh that.

To trace the period, and the hiſtory of this new form of the Botanic Study, is to do more honour to this CÆSALPINUS: we ſee him riſe alone from the full crowd of thoſe who thought it was enough to number and deſcribe the Plants; and tho' the improvement he propoſed was evident to all the world, yet for ſo long a ſpace of time none followed him. He appeared ſingle; and tho' reſpected, was unimitated. There was danger his diſcoveries would periſh with his name. But tho' we muſt give the invention of ſyſtem to a ſtranger, our countrymen revived it after this neglect. One hundred and three years after CÆSALPINUS, MORISON, a Briton, entered earneſtly, and not unhappily, into the ſame path. RAY followed, whom an accidental ſervice to a friend, led into the full road of ſcience: our biſhop WILKINS, then buſied in his REAL CHARACTER, deſired of RAY an arrangement of the Vegetable World, ſuited to the purpoſe of that work. This firſt directed the mind of that great man, ſeriouſly and attentively to the claſſing and arranging of Plants; a ſtudy to which he afterwards devoted himſelf in a manner entirely; to the great benefit of the Botanic World. He formed a method which, tho' full of imperfections, yet comes nearer nature than, perhaps, any other. KNAUTIUS followed RAY, and HERMAN him: RIVERIUS was cotemporary with KNAUTIUS; theſe both wrote in the year 1690. And after four years more followed TOURNEFORT, the greateſt of them all.

THUS cloſed upon the ſcience the ſeventeenth century; in the laſt ſeventeen years of which, the long neglected inſtitution of CÆSALPINUS was ſo well revived, that there appeared no leſs than ſix diſtinct Syſtems of Plants; and each of very conſiderable merit. The authors of the four firſt held the Fruits and Seeds, according to the original practice of their great maſter, to be the propereſt, at leaſt the moſt eſſential, parts on which to found a Syſtem. RIVERIUS ſtruck out the deſign of fixing the Cha-

racters in the FLOWER; and TOURNEFORT purſued this with an attention, induſtry, and truth, which did honour to the Sovereign under whoſe patronage he wrote.

BOERHAAVE opened the eighteenth century: a name, which if it did not ſhine with greater luſtre in the other ſciences, would be eminent in Botany. RAY yet lived, and continued his uſeful labours, adopting more and more parts of Plants to his diſtinctions. BOERHAAVE continued the ſyſtem in its original courſe, making the Fruits and Seeds of Plants his great objects in their arrangement.

IN 1711, HEUCHER of Wittenberg appeared with credit; and led in a long train, who leſs regarding the original object of diſtinction, followed RIVERIUS and TOURNEFORT in the choice of the Flower. Seven years after RUPPIUS wrote, adopting the ſame part as the foundation of his ſyſtem; and this continued the eſtabliſhed doctrine with PONTEDERA, HEBENSTRET, and LUDWIG.

IN the mean time MAGNOL diſtinguiſhed himſelf by a new Syſtem, formed upon the Conſtruction of the Cup; and in the year 1735 LINNÆUS, too great for praiſe, after having unſucceſsfully propoſed his new thoughts in England, publiſhed in Holland that Syſtem of Plants which characterizes the Claſſes according to the Filaments and Style; and takes into the Generical Diſtinctions all the Flower. This ſyſtem the ſucceeding four and twenty years have more and more eſtabliſhed; and if we may conjecture from its value, it will live (even when a natural method ſhall be found) ſo long as there is ſcience.

THE END OF THE FIRST BOOK.

BOOK II.

OF THE

VEGETABLE STRUCTURE;

AND THE

LIFE OF PLANTS.

INTRODUCTION.

WE have ſeen the Progreſs of Botany, and the Riſe of Syſtems; and there will be a place to examine each: to ſhew its merit and defects; and to enquire how far theſe may be ſerviceable to the eſtabliſhing that great article A NATURAL ARRANGEMENT OF PLANTS: for all hitherto are merely artificial.

To advance by regular ſteps towards this great object, we are firſt to enquire what Vegetables truly and diſtinctly are; what place they hold in the general arrangement of natural bodies, and by what diſtinctive Characters they claim that ſeparate department; of what ſubſtance they are compoſed, and what is their internal ſtructure; what portion or degree of Life it is which they enjoy: and laſtly, what thoſe exterior parts are, and whence deduced,

ced, on which theſe artificial ſyſtems have been, and on which a natural method may be eſtabliſhed.

WITH this knowledge of the ſubject in general, and of its particular diviſions, we may be able to judge how much is natural in every ſyſtem, and how much imaginary; what is the true advance each author has made; and how far his diſcoveries or conceptions may be aſſiſtant in the point deſired. The Vegetable Conſtruction, and the dependant Life of Plants, will be the ſubjects of the preſent Book. This is properly the Philoſophy of Plants, extending to all ranks and orders of the Vegetable Syſtem. The exterior parts vary in different ſubjects; but yet they are in all an eſtabliſhed, and that a very limited number. Theſe will be the ſubjects of the ſucceeding diviſion: and as all Syſtems are eſtabliſhed upon theſe; and all arrangements, and all diſtinctions of them, from Claſs to Species, have their foundation in the difference of thoſe parts; when they are explained, and not before, the Diſtinctions, Characters, and Names in Botany may be underſtood.

CHAP. I.

The PLACE of VEGETABLES in the SYSTEM of NATURE.

VEGETABLES, the knowledge of which is BOTANY, hold a middle rank in the great orders of the Creation. Natural bodies are arranged into three claſſes, diſtinguiſhed eaſily, and utterly diſtinct from one another: theſe we call MINERALS, VEGETABLES, and ANIMALS. The general ſtudy of all is NATURAL PHILOSOPHY; and the particular detail conſtitutes NATURAL HISTORY. BOTANY regards only the Vegetable Claſs; but it comprehends ſo far, both doctrines; extending to the Philoſophy as well as the Hiſtory of Plants.

To enter properly upon the ſtudy, we are firſt to aſcertain its objects, in diſtinction from thoſe of the other two great Claſſes. The out-lines of the diſtinction are theſe. Minerals have increaſe without life, organized parts, regular growth, or ſenſation; Vegetables have a regular growth, and a degree of life, but no ſenſation; Animals grow, live, and feel. Minerals have no veſſels; Vegetables have veſſels for their nutritive juices; Animals have nutritive veſſels and nerves; theſe laſt are a peculiar and diſtinct ſyſtem. On this conſtruction depends the eſſential, univerſal, and invariable difference of the three great claſſes of material beings. Minerals wanting veſſels, tho' they may be increaſed by an addition of parts, cannot have a regular

regular growth; for that muſt depend on veſſels. Plants having veſſels, may have a regular growth; for it is the effect of their proper office: but wanting nerves, they cannot feel; that being the quality of nerve alone. Animals which have nutritive veſſels and nerves, grow and feel; theſe being the offices of thoſe two ſyſtems.

THIS eſtabliſhment of the characteriſtick of Animals in a ſyſtem of nerves will appear ſingular; for every opinion does ſo when it is firſt propoſed: but, probably, more obſervation will the more confirm it: all I have been able to obſerve, has this plain tendency; and certainly there wants ſuch a fixed mark for the ſeparate character. Nature made the mineral, vegetable, and animal world diſtinct; and nothing is diſtinct except it have ſome ſuch invariable character of the diſtinction: this has been unluckily traced hitherto, and even the greateſt naturaliſts have endeavoured to find it in characters that were equivocal: many minerals have a regular form; and there are Plants which are not fixed to one place; and animals which are: yet theſe have been the uſual marks of ſeparation. Anatomy teaches us diſtinctly what the nerves are; and by that ſyſtem we ſeparate the two greater claſſes: the minerals are ſufficiently diſtinguiſhed from both, in their nature and obvious appearance. Nature makes all her changes by minute gradations, nor is there any great gap in the univerſal chain. Thus the Senſitive Plant approaches towards the animal kind, in motion; and the Duſty Byſſus ſcarce enjoys an apparent diſtinction from the earth on which it grows: yet with a fixed character once eſtabliſhed, there can be no difficulty or confuſion.

VEGETABLES are placed by Nature in a middle ſtate, between the mineral and the animal claſſes: ſuperior to the minerals, in having organized bodies; inferior to the animal kinds, in wanting a nervous ſyſtem. They are capable of growth, but below ſenſation.

CHAP. II.

Of the CONSTITUENT MATTER of VEGETABLES.

WE are accuſtomed to conſider the Matter of Vegetable and Animal Bodies as diſtinct; but all may be reduced by fermentation to the ſame ſubſtance. This fermentation is a plain and regular operation of nature; which always takes place, in vegetable and animal bodies, when they ceaſe to live and grow; and needs no human art to help it. A piece of the

the fleſh of a dead Animal, and the bruiſed ſtalk of a Plant, left to themſelves, deſtroy themſelves thus by their own power. They grow moiſt, they heat, they diſſolve into one ſoft offenſive maſs; and there is no knowing from any quality in that matter, which was of animal, or which was of vegetable origin. The animal and the vegetable nature are loſt utterly; and each of the bodies is reduced to a ſubſtance neither animal nor vegetable in its nature, but capable of being converted into either; of feeding equally Animals or Plants. So true it is, that Matter, as Matter, has no concern in the qualities of bodies; but all depends on its arrangement: hence water, which is taſteleſs, feeds aromatick Mint; and the ſame earth gives nouriſhment to bread and poiſon. This ſolves the problem, of the ſame earth yielding innocent and hurtful Plants: and it is no common pleaſure to obſerve, that the doctrines of our celebrated NEWTON are never ſhaken by true experiment; but the more ſtrictly we examine nature, the more they are confirmed.

IT is not the matter which originally conſtitutes a Plant, that makes it acrid or bitter, eſculent or poiſonous; for Matter, as Matter, is all alike: the qualities of Vegetables depend upon the arrangement of thoſe common particles; and this arrangement being made by the veſſels of the Plant, it muſt be different where they are differently conſtructed. What thoſe veſſels are, and how they are diſpoſed in various Plants, will be our next ſubject; but thus much we may ſee upon the ſlighteſt view of Vegetable Nature; that the conſtruction of various kinds is extremely different; and that this variation of form is owing plainly to the conſtruction and diſpoſition of their veſſels: and as we find their qualities differ as much as their forms, and are, in ſome degree, connected with them, we need not look further for the cauſe. As we advance in this plain path, we find the traces of that truth marked yet more ſtrongly: the difference of Plants from Plants, is not by a wide and important diſtinction between individual and individual throughout the whole ſyſtem: the great and palpable characters of variation, belong not to ſingle vegetable bodies, but are common to great numbers, in diſtinction from other numbers equally large. Theſe conſtitute the natural claſſes of Plants; which, however undiſcerning man may have confuſed or overlooked their characters, are really but few.

CERTAIN Plants have hollow, jointed ſtalks, and ſingle narrow leaves, huſky cups for the flowers, and ſingle ſeeds in them. This character diſtinguiſhes not one Plant from all the reſt, but one vaſt family, the Graſſes, from all other families of Plants. In the ſame manner, others have flowers in round ſpreading tufts called umbells, and two naked ſeeds following each,

each, with five ſmall filaments in every flower. Theſe are the Umbelliferous Plants. The moſt minute parts of their flowers agree in this number, and this is again the character and diſtinction of another multitude of Plants; all of which agree in every particular of this conſtruction; and differ by it from all others. Certain other Plants produce their ſeeds in little Pods, and have four of the ſmall filaments which ſupport the antheræ in their flowers longer than the others: ſlight as this mark appears, it is moſt conſtant. Theſe are the Siliquoſe Plants: and this is, as the preceding, the character by which a large aſſortment of Herbs differ from another great aſſortment or claſs; not one from all the reſt.

THERE can be no doubt, but the ſtructure of the veſſels of the Plants occaſions this difference in their forms: for there is no other cauſe; and nothing is effected without one: but we ſee alſo, that theſe arrangements of Plants, as they are ſepara ed from all others by thoſe characters, have alſo their peculiar and appropriated virtues; common among themſelves, and diſtinguiſhing them from others. Thus, all the Graſſes and Corns are eſculent: the leaves are food for cattle; and the ſeeds for the human ſpecies, and for a variety of other animals. The Umbelliferous are warm and aromatick, and the Siliquoſe Plants are acrid and deobſtruent. Theſe obſervations hold generally true; and the ſame agreement of virtues in thoſe Plants which have the ſame characters of diſtinction, will, I believe, be found throughout the whole Vegetable Syſtem, when a true natural method ſhall be eſtabliſhed. This agreement of Plants of the ſame claſs in their virtues, has been obſerved by many; but the great and plain truth which it may teach, ſeems to have been overlooked entirely. It is allowed, that Plants have very diſtinct forms: it is allowed alſo, that this diſtinction of form depends ſolely on, and ariſes only from the different conſtruction of their veſſels: we find Plants which have a like conſtruction of veſſels, have like marks of diſtinction from them; and that they have the ſame virtues: does it not follow, that as the form common to ſo many, depends upon the peculiar conſtruction of thoſe Plants, ſo do their virtues; which thoſe of the ſame form, that is of the ſame vaſcular conſtruction, poſſeſs alſo in common?

THIS brings us to the Point whence we ſet out. The Matter which compoſes Plants is the ſame in all the kinds: it is arranged into as many forms as God created Species in the beginning of things; to which there has not been one addition ſince, nor one loſt from the number: according to the arrangement of this common Matter, it acquires peculiar qualities

and virtues; the Matter being ſuſceptible of any form, and from that form deriving all thoſe qualities.

We know what things they are which feed and form a Plant; and we know theſe are the ſame in all the kinds. One parcel of mould will produce every ſpecies; one quantity of water moiſten that earth for all; and they all grow ſurrounded by one atmoſphere. We may eat this mould without hurt, we drink this water, and we breathe this air. Yet from a ſeed of Deadly Nightſhade ſown in this, riſes a leaf, a dram of which is poiſon. The burning juice of Spurge, or the bitter of Gentian, are neither in the earth, the air, or water: theſe are compoſed of matter ſuited equally to the formation of all bodies; and ready to form any into which they are thrown; this matter is inert in itſelf, and poſſeſſes no quality but its own firmneſs. The veſſels of the Plants arrange it differently; not only in different ſpecies, but in the diſtinct veſſels of the ſame Herb; and this arrangement gives to the common matter ſcent and taſte, colour and virtue. Do we need more proof that it is the form into which matter is thrown, which gives bodies all their qualities? Let us obſerve the effects of thoſe ſimple operations, which, under our own eye, put various ſubjects into different forms. In many minerals the ſubſtance itſelf is innocent; but lay it on the fire, and its vapour is poiſonous. And in Vegetable Bodies, our immediate ſubject, the ſame ſubſtance often poſſeſſes, in ſucceſſion by theſe changes, three diſtinct qualities; one while in the ſtate of nature, a ſecond while fermenting, and, after it has been fermented, another different altogether from both. We cannot doubt, but the matter which riſes in vapour from the mineral, is the matter or ſubſtance of that mineral; and as we find it innocent in the one ſtate, and fatal in the other, it cannot be but the different arrangement of the parts of the ſame matter, makes this great difference. The vapour of fermenting wine, riſes from the innocent Grape; and neither that, nor air, nor water, have ſimply any fatal qualities. We find ſo many things can make this change in matter, that we need not wonder a conſtruction ſo complex and delicate, as we ſhall preſently ſee the vaſcular ſyſtems of Vegetables to be, can effect it. Plainly, the original particles of all matter are the ſame. The vegetable ſubſtance is compoſed of the ſame body with that of animals and minerals; and while the earth feeds Graſs, the Graſs an Ox, and the Ox a Lion, the proper and unaltered ſubſtance of matter paſſes alike thro' all; and is the ſame in all; tho' differently arranged in the ſeveral ſpecies. Spontaneous fermentation diveſts it, after all theſe changes, of the ſeveral forms and qualities it received from thoſe various bodies, and retained while

in them; and being reduced by this natural operation to its first state, it is ready equally to feed, and fill, and compose one or the other of them. THALES, the Greek, said all was formed of water. He seems to mean, that all bodies are composed of one and the same matter, which is insipid, and void of every quality. This matter, he supposes, tho' composed of solid particles, to have been originally fluid; as that condition rendered it most easily susceptible of the various necessary arrangements. Solidity in these appeared to him a condition of restraint: and, perhaps, there was perfect truth in this philosophy.

CHAP. III.

Of the ARRANGEMENT of MATTER into a VEGETABLE BODY.

THE first view we take of a Vegetable, gives us an idea of an almost infinite number and variety of parts, different in form and structure; and we are led to consider it as complex in so high a degree, that the arrangement of matter for the forming all those parts, seems in every individual a new miracle. The ROOT, the STEM, the CUP, the PETALS of the Flower, the FILAMENTS, and the SEED VESSEL, are all distinct from one another in COLOUR, FORM, and OFFICE. Thus much appears of difference externally; and when we attempt the least article of a dissection, there arise new wonders, in the construction of each part, and its peculiar vessels. These are of one kind in the outer, and of another form and structure in the inner rind, still different from both in the internal parts, and full of new variety. The appearance has disheartened many from prosecuting the research, who might have made discoveries; for large draughts are needful of this spring, and they are, indeed, PIERIAN.

PERSEVERANCE in the examination, will divest the subject of all this seeming intricacy: the parts which appeared so numerous, will be reduced to a very small account; and the two sources of variety will be reduced to one.

A CAREFUL Maceration, in soft water, will separate the real parts from one another, and shew that many are but distinct in appearance. By dissolving the parenchymatous substance of entire Vegetables, we obtain the vascular parts, separate from one another, and entire: and whensoever we begin the account, we find them only seven. These are, 1. an

outer Bark; 2. an inner Rind; 3 a Blea; 4. a Fleſhy Subſtance; and 5 a Pith. There is, indeed, between the Fleſh and the Blea, 6. a Vaſcular Series; and 7. Cones of Veſſels take their courſe within the Fleſh: theſe are properly as diſtinct parts as the five more obvious ones, and theſe are all.

WHATEVER part of the Plant we examine, we find theſe, be it a Fibre, the Body of the Root, or the Stem. We never find more: and tracing theſe thus ſeparate from all other parts of the Plant, we ſee the other, or external portions, are only productions of them. All the imaginary complex ſtructure of the Plant beyond this, vaniſhes in an inſtant, like thoſe inchanted caſtles in romance, which when the taliſman is broke, diſappear. The Root, its deſcending Fibre, and the aſcending Stalk, we thus find are one, and not three ſubſtances: the ſame ſeven parts compoſe them; and they are continued from the one to the other, or formed by the proceſs of growth. This reduces the entire Vegetable to one body; and what are ſuppoſed at its ſummit to be many new and ſtrange parts, are found to be no more than the natural extremities and terminations of the ſeven ſubſtances which form the entire body. Theſe external parts alſo are ſeven; 1. the Cup; 2. the outer Petals; 3. the inner Petals; 4. the Nectaria, either viſibly diſtinct, or connected in one thick ring; 5. the Filaments; 6. the receptacle of Seeds; and 7. the Seed-Veſſels, or Seeds. Of theſe parts of a Flower five only are accounted generally; for it has not been obſerved, that there is a diſtinction of outer and inner Petals univerſally in Flowers; nor has it been remarked, that where there are not viſible Nectaria, a thick and jointed cord always ſurrounds the baſe of the Receptacle. This will appear on more obſervation. The ſeven exterior parts never fail to be found the terminations only of the ſeven conſtituent ſubſtances of the Plant; when the maceration is well managed. The Cup terminates the outer Bark, the inner Rind ends in the outer Petals, the Blea forms the inner Petals, the Vaſcular Series ends in the Nectaria, and the Fleſh in the Filaments; the Conic Clufters form the Receptacle, and the Pith furniſhes the Seeds and their Capſules. This is the general conſtruction of a Vegetable Body; it will be illuſtrated in the ſucceeding chapters, by particular inſtances, but here the entire view of the ſubject was neceſſary. We ſee by it, that theſe fourteen parts, ſeemingly ſo different, are reduced to ſeven: and we ſhall ſee theſe are univerſal in Plants; tho' their courſe be leſs plain in ſome, and their terminations leſs diſtinct in others. As to colour, we ſhall find that accidental, the ſame outer Rind is Brown in the Root, green on the Stalk, and Red in the Cup perhaps;

Black Helebore ?

perhaps; while it is all found by this maceration to be one piece, one continued ſubſtance.

EVERY piece cut from a Plant tranſverſely, therefore, contains all the parts of the Plant, ready to grow in length, into a Stalk upwards, and into a Root downwards; and to ſeparate, at a due height from the Root, into the ſeveral parts of a Flower. This is plain and certain from the experiment; and this ſets aſide all the vague, and indeed abſurd, opinions of Trees in their Seeds, and the innumerable Germs around their Trunks and Branches. Any tranſverſe piece of a Plant, if it be preſerved from rotting, is capable of growth; and every Seed contains what was originally in the globule of Farina, a detached piece of the Fleſh, or eſſential part of the Plant; which is equally ready to grow as the other. The production of Plants from Cuttings, and from Seed, is therefore the ſame, only that the one is ſeparated by violence, and the other by the courſe of growth.

THUS we ſee the arrangement of the common particles of matter into a Vegetable Body, altho' it be a work highly perfect, and worthy of his hand who formed it, yet is not ſo complex a thing as it appears: and that this arrangement being once made in one individual, the ſpecies is created for ever: for growth is the conſequence of the arrangement, when it has heat and moiſture; and there is no generation among Plants.

THIS is the general ſyſtem of Vegetable Bodies; and we may from this proceed regularly to the detail of their parts.

CHAP. IV.

Of the PARTS of PLANTS.

A PERENNIAL of a firm texture, and not too complex compoſition, will be the fitteſt ſubject for ſeparating the parts: I have therefore choſe the BLACK HELLEBORE; a Plant which conſiſts only of a Root, Radical Leaves, and a Flower Stem; and which is ſo hard in its ſubſtance as to blow in our coldeſt ſeaſons.

THERE is another eſſential reaſon why I have choſen this Plant: to underſtand the parts properly, we muſt have them ENTIRE; and to begin from the true foundation, we are to trace them all from the extremities of the Fibres of the Root, to the part wherein they terminate.

IN

In moſt Plants theſe Fibres of the Root run to an extreme length; and terminate too ſmall for ſight, and too tender to be taken entire out of the earth. Theſe, therefore, we could not examine: but in the HELLEBORE the Fibres of the Root are not more than five or ſix inches long; they may be taken out of the ground entire; and their extreme terminations are as thick as a large pin. Therefore they can be examined eaſily. See Plate I. where the Plant is repreſented in its natural ſize, and with all its parts.

CHAP. V.

The PREPARATION of a FRESH ROOT of HELLEBORE for this ENQUIRY.

ON the firſt day of January, 1759, I dug about a Plant of Black Hellebore, at eight inches diſtance every way, clearing out the mould to two ſpades deep; then getting the ſpade under the ball of earth left with the Root, raiſed it entire. I laid this ball, with the Plant in it, under the ſpout of a pump, and pumped on it gently, cleaning at the ſame time between the parts with a Camel's Hair Pencil, till all the earth was waſhed away; and the uninjured Fibres were left clean and entire.

THIS is the Root which I have deſigned in the annexed Plate, with the entire Plant growing from it.

CHAP. VI.

EXAMINATION of a FIBRE.

FROM this Root taking off a Fibre near its head, we ſee it is thick at the top, gradually diminiſhing to the other end; and at different diſtances from the body of the Root it has three diſtinct appearances. If we make an imaginary diviſion of its length into three parts, as at Plate II. Fig. 1.—1, 2, 3. we ſhall ſee it is of a pale brown, and ſmooth, the firſt third of its length; the ſecond part is of a duſkier brown, and ſhaggy; and the third portion is ſmooth, whitiſh, and nearly pellucid. It ſends out no ſub-

ſubordinate Fibres; and the end is not diminiſhed into an inviſible point, but has a fair largeneſs for the view, and is terminated by a kind of button, 4. I have added it diſtinct, and a little magnified at *9.

THE portion (1) is of the nature of the body of the Root. Its ſurface is entire and ſmooth; it receives no juices from the earth, but conveys and improves thoſe received below. The part 2, draws the principal nouriſhment; the ſhaggy ſurface is compoſed of Fibres of a peculiar kind. The part 3, is as yet only in the condition of one great Fibre. It will be proper to examine firſt the ſurface in theſe three parts, and afterwards the internal ſubſtance.

To this firſt purpoſe a thin piece of the ſurface ſhould be taken off the whole length of the Root, with a very delicate Knife: and a piece of each part laid before the Microſcope. The piece of part 1, marked Fig. 5, is a plain ſmooth piece of rind, with nothing riſing from off its ſurface. Veſſels appear within it, but of thoſe we ſhall treat hereafter diſtinctly.

IN the piece of part 2, figured here at 6, we ſee the ſhaggy ſurface is compoſed of little Fibres. Theſe are ſhort, pellucid, and very ſimple in their ſtructure. We ſee in this piece the courſe of the Veſſels, as in the former; and theſe Fibres take their origin always from theſe, and never from the interſticial ſubſtance.

To examine one of theſe ſmall fibres exactly, it will be proper to cut off a very ſmall ſegment of the piece 6, and laying it in water before the double Microſcope, with a powerful magnifier, we ſee it as expreſſed at 8; differing in nothing from the part 3 of the large Fibre, except that it is more pellucid: it is a plain, ſimple, uninterrupted tube, terminated by a ſmall button at the extremity, juſt as the longer Fibre. Theſe twiſt themſelves variouſly about, and the clubbed ends reſembling the heads of Animals, they appear ſo many little ſerpents, or dracunculi, darting their ſmall heads about with fury.

THE part remaining to be examined of the ſurface of the Root, is the third diviſion or extremity. This being the ſame with the Fibres juſt named, only larger, will ſerve happily to diſcloſe alſo their ſtructure, Fig. 7. It appears ſimple; but when larger magnifiers are uſed, we find it, like the other parts, vaſcular: only all is more delicate. The great object of attention is the terminating Head or Button.

CHAP.

CHAP. VII.

Of the HEAD which terminates the FIBRE.

THE naked eye may ſee this head at the extremity of every Fibre plainly, in a Root thus cleaned: and it is impoſſible to look on it without ſurpriſe; it is ſo different from what the received opinions ſay concerning the extremities of Fibres. They are ſuppoſed ſmall beyond all view, and open. On the contrary, we ſee them here enlarged and cloſe. The greateſt wonder is, that a thing ſo obvious, in a regular enquiry, ſhould have eſcaped the obſervation of Naturaliſts ſo long. The depth of Winter is the time to make theſe obſervations; for the warmth and wet of Spring make great changes in the Fibres.

To the naked eye one of theſe heads appears obtuſely conical, larger than the adjoining part of the Root, and altogether different in colour and ſubſtance; that is colourleſs and tranſparent, this part is opake and yellow. No more appears till we cut it open.

A TRANSVERSE ſection of this part ſhews a very delicate conſtruction, and very wonderful: but we ſhall be more familiar with the parts which compoſe it as we advance farther in the Anatomy of the Plant: for tho' they be thickened in a peculiar manner, they are the ſame ſeven parts which compoſe the reſt of the Plant. See Fig. 10, 11.—counting from the centre, they are thus diſpoſed.

THERE is a cavity in the middle of the head, and this is ſurrounded with a thin lining of white Pith, the ſame with the Pith of the Stalk or Fibre; round this is carried a thick coat of a greeniſh ſubſtance, which is the Fleſh of the Plant, the fifth conſtituent ſubſtance of Plants, reckoning from the ſurface; and near the inner edge of this are placed ſix conic cluſters of veſſels, whoſe points pierce the Pith. Theſe are the ſixth conſtituent ſubſtance in all Plants. On the outſide of the coat of Fleſh runs a vaſcular ſeries; it appears only in diſtinct Dots, but is compoſed of Veſſels incloſed between two Membranes; this is the fourth ſubſtance in all Plants. Over this is a very thick coat of the Blea; which is whitiſh, and upon this are ſpread the two Rinds, the innermoſt of which thickens at the end of the head, into a kind of jelly. All theſe parts go compleatly round this head or extremity of the Fibre, returning upon themſelves in ſo many arches; and there is no opening at the end of the Fibre;

Fibre; their courſe, as ſeen in a longitudinal ſection, is ſeen at Fig. 12. And if from theſe we direct the eye to the tranſverſe and longitudinal ſection of a Fibre, Fig. 13, 14. we ſhall ſee the ſame parts moſt diſtinctly: for the ſeven ſubſtances are the ſame in the body of the Fibre, and in this ſingular head at its extremity; only that they are all larger, firmer, and more diſtinct in the body of the Fibre, and more tender, ſoft, and delicate in its head. Innumerable veſſels are ſent from the Fleſh of the Plant thro' the Blea, as alſo from the Blea into the rinds in this part, for drawing nouriſhment, but none pierce the ſurface. The whole coat is ſpungy.

THAT Nouriſhment which this part of the Root receives from the earth, is not taken in at an open extremity, as was imagined; but enters the ſpungy cavities of this head; and being received into its ſubſtance, penetrates, in the ſame manner, the ſurfaces of thoſe Fibres which run into this part from the other coats; and is thence diſtributed to the entire Plant, thro' their veſſels.

THIS ſyſtem is new; but the eyes are its evidences. The fourth Magnifier of the common Double Microſcope ſhews it diſtinctly enough to aſcertain the fact, that the end of a Fibre is a hollow head, where all the coats are continued round, and which has no opening: and the greater Magnifiers ſhew the communications of the Veſſels as diſtinctly.

THE other opinion, that the extreme Fibres of Plants opened in a kind of Mouths at their ends, was, indeed, contradictory to reaſon; for the Juices muſt, in that caſe, have been received into the hollow where the Pith lies, whence there is no proper communication with the ſix other ſubſtances of the Plant. Perhaps the nouriſhment of Animals is received in the ſame manner, and the extremities of the Lacteals may be formed thus. One inſtance in animal nature there is which I have found plainly analagous: this is the Gordius, or Hair-worm. This creature has no mouth: its head is covered with juſt ſuch a gelatinous ſubſtance as the end of the Fibres in this Plant; and all its nouriſhment pierces the pores in the ſame manner.

IN Vegetable Nature every thing confirms this ſyſtem; and therefore, altho' new, it will, I flatter myſelf, be favourably received. When Roots are ſhortened in tranſplanting, they firſt ſend out a gelatinous covering of this kind: and when Cuttings are planted, the firſt effort toward their growth, is a callous knob covering the wound. The Juices differ in theſe ſeveral inſtances, and therefore the ſubſtance of the head differs alſo in its firmneſs; but the proceeding is the ſame in all: Nature admits no

Juices to the Veſſels of a Plant, but thro' the fine pores of ſuch a head; and they are thence only given to the Veſſels which run thro' the Body.

CHAP. IX.

The INTERNAL CONSTRUCTION of a FIBRE.

WE have ſeen the Surface and the Termination of a Fibre of the Hellebore Root; and the diſſection of that laſt part of it naturally leads us to the Anatomy of the whole. For this purpoſe, we are to chuſe an entire healthy and ſound Fibre, taken freſh out of the ground at the ſeaſon named before; and to examine it by tranſverſe ſections, and by ſplitting. The parts are moſt diſtinct in that portion which is next the body of the Root: therefore it will be beſt to cut it aſunder at about half an inch from its inſertion.

IN a thin ſlice cut tranſverſely from this part of a Fibre, and laid before the Microſcope, we ſee ſeven conſtituent parts very diſtinctly. Fig. 13. 1. An outer Rind; 2. an inner Rind; 3. a vaſt white Blea, compoſed of hexagonal Veſſels; 4. a ſingle ſeries of greeniſh Veſſels; 5. a greeniſh fleſhy ſubſtance; 6. ſix conic cluſters of Veſſels; and 7. a ſnow white Pith, formed of Veſſels extremely minute.

So much a tranſverſe ſection ſhews. When we ſplit the Fibre directly along the middle, we ſee the ſame parts diſtinctly in the ſame proportion; and on laying a thin piece of ſuch a ſection before the Microſcope, we diſcover the Veſſels of which each part is formed. See FIG. 14.—1, 2, 3, 4, 5, 6, 7.

THESE ſeven parts continue their courſe to the extremity of the Fibre, and rounding that extremity in ſo many arches, return without interruption up again to the inſertion of it at the body of the Root. The next obſervation leads us therefore to that inſertion.

THIS is the plaineſt that can be conceived. There is no Joint, no Knot, not ſo much as a Gland, or Ganglion, at the part: but the two Rinds, and the Blea, and Vaſcular Series of the Fibre are continued plainly and ſimply into the Rinds and Blea, and the Vaſcular Series of the body of the Root. Fig. 15, 16. *e*. Thus far the Root and its Fibre are one continuous and regular body: but the Fleſh, the conic Cluſters, and the Pith, are diſtinct in each. 'Tis eaſy to ſee now in what manner a

Fibre is produced from the body of the Root: for tho' we have been obliged in the due courſe of enquiry to begin at the extremity of the Fibre, and follow it to the Root; that Fibre is, in the courſe of Nature, produced from the body of the Root, not the body of the Root from it. We are therefore now to change the courſe of examination, and conſider the body of the Root: and are to trace this Fibre carefully from it.

CHAP. X.

The CONSTRUCTION of the BODY of the ROOT.

THE body of the Root in Hellebore is ſmall; not tuberous, nor bulbous, nor of any determinate form; but a mere oblong, ſimple lump, irregular in ſhape, and compoſed of the ſame parts with the Fibres, which are thus diſpoſed.

IN the center is lodged a conſiderable quantity of Pith, incloſed in the Fleſh and its Coats, and there kept diſtinct and ſeparate from all other parts; having no connection with, nor continuation into any of them. This Pith follows the courſe of the Root in all its irregularities, at an equal depth within, and equal diſtance from its ſurface; nowhere coming within an eighth of an inch of the Rind, nor any nearer at the ends than elſewhere. Fig. 16. *a. b.* We ſee it is a mere exſudation of the fleſhy ſubſtance of the Root, which ſurrounds it; produced from that, and producing nothing. This Pith is of a whitiſh colour, with a tinge of yellow. 16. 1.

JUST upon the verge of the Pith run the conic cluſters of Veſſels, ſcarce ſeen in a longitudinal ſection. 16. 2. The ſubſtance covering theſe is very firm, as broad as a ſmall twine, and of a greeniſh yellow. Fig. 16. 3. This is the Fleſh of the Root, and in the preſent inſtance it is very ſolid. It is eaſy to ſee by the connection of the Pith with this, that it is its proper lining; and is regularly produced from it.

THIS fleſhy coat follows the courſe of the Pith, and in many places ſhoots proceſſes of its own ſubſtance into it, and even thro' it, appearing like lines in a map, or letters of the alphabet. 15 c. Theſe ſerve to ſupport the two ſides of the Fleſh, at equal diſtance, where the Pith would not have ſtrength enough to do it; and they divide it in a manner into ſo

many portions. This fleſhy ſubſtance is every where at an equal diſtance from the ſurface, rounding the baſe in form of an arch or ſhell; and what may appear more ſtrange, but is equally certain, purſuing its courſe in the ſame vaulted form at the top of the Root, 16, b. and under all the Fibres, 16, b. Tho' it ſends out a part of its uter ſubſtance into them.

THUS terminates the Pith, the conic Cluſters, and the Fleſh, forming arches within the common coats, and returning upon themſelves; but it is not ſo with the other parts. Next above the Fleſh appears the Vaſcular Series, 16. 4. tho' very indiſtinctly in the longitudinal ſection: and over theſe lies a thick white Blea, 5. This is continued in an arch round the baſe of the Root, but it has no ſuch termination at the head, 16, d, for there it runs up into the Stalk, making the ſame third part in its ſubſtance.

NEXT above this we find the inner Rind of the Root, 6. This is of an uncommon thickneſs, and is pellucid, and almoſt colourleſs, or of a very faint greeniſh white. This makes the gelatinous part of the heads of the Fibres, and is nearly of the ſame ſubſtance here.

OVER this is carried the outer Rind, 7. which is brown and thin. Theſe are all the conſtituent parts of the body of the Root: of which the three innermoſt alone are peculiar in a manner to it. The reſt are continuations of the ſame parts in the Fibres, and are continued alſo into the Stalks.

CHAP. XI.

Of the INSERTION of the FIBRES at the BODY of the ROOT.

THE body of the Root is the original part produced from the Seed of the Plant. It is, indeed, the Corculum or Heart of the Seed ſwelled and enlarged into that form; and the Fibres as well as Shoots for Leaves and Flowers are all produced from it. The Fleſh in the Stalk of the original or parent Plant, furniſhed that Heart of the Seed; and this fleſhy ſubſtance of the Root is the ſame thing ſwelled to a larger bulk. Its Pith has been thrown out from its own Veſſels inward; and the ſeveral Coats externally have been produced in the ſame manner by its extravaſated Juices hardened into a ſubſtance; and by continuations of thoſe Veſſels themſelves in ſlender branches into it. Thus the fleſhy ſubſtance in the body of

of the Root, is the eſſential part of it: the reſt having been produced from this: and ſo we ſhall find have all the other portions of the Plant. Firſt we are to trace its Fibres.

When we have laid open the body of the Root lengthwiſe, it will be eaſy to cut off a Fibre at a ſmall diſtance from the ſurface, and ſplitting this along the middle, and carrying the knife in the ſame even line into and thro' the ſubſtance of the Root, we ſhall ſee plainly in what manner it is produced from it. Fig. 17. *a b c d e.*

The Fibre, we have ſeen, is compoſed of all the ſame parts as the body of the Root. The two Rinds, and the Blea, and Vaſcular Series, are, indeed, continuations of thoſe parts entire from the Root; the Fleſh is a portion of the ſurface of the Fleſh of the Root; but the conic Cluſters and Pith are ſyſtems peculiar to each part. The origin of the Fibre is from the outer ſurface of the fleſhy ſubſtance of the Root: 17, a. This part keeps its uninterrupted courſe along the body of the Root, even where the Fibre has its riſe, 17, b, and forms a yellowiſh line between the baſe of the Fibre and the Pith, 17, c; but a part of its outer ſurface is raiſed horizontally in form of a ſmall bliſter, whoſe crown is very thin, and whoſe body in a ſection repreſents two threads, 17, d e, a little diſtant one from the other. This Bliſter thruſts out all the coats of the Root in that part; and is the original of the Fibre. The Blea, where it is puſhed by the tops of theſe two threads of the fleſhy ſubſtance, goes with them outward with a ſmall proceſs; and ſo do the two Rinds. The fleſhy threads are continued in length, and theſe three parts being alſo continued with them, a Fibre is formed, ſuch as has been deſcribed; compoſed of a fleſhy ſubſtance, a Blea, and two Barks, which are the ſame with thoſe parts in the original Root, and, indeed, muſt be, becauſe they are thoſe parts themſelves, only thruſt outward. Theſe accompany the courſe of the Shell or Threads of fleſhy ſubſtance, till they have reached ſix or ſeven inches, which is the natural length of the Hellebore Fibre; and there the two threads which were at firſt one continuous ſubſtance, being only a kind of bliſter riſing from the outſide of the fleſhy ſubſtance of the Root, form an arch or vault: this terminates that part of the Fibre. The three Coats, and the Vaſcular Series, are only the proviſions of Nature for its ſecurity, and really nothing more than productions or continuations of the ſame parts from the body of the Root, for its ſervice: theſe form the ſpungy ſubſtance of that ſingular head before deſcribed, and make a thick vault over it; and the others in the ſame manner ſurround it, not terminating, as has been ſuppoſed, at its extremity.

THUS we learn the true nature of a radical Fibre. It is not a new production from the Root; but is truly a part of the ſubſtance of the Root itſelf, firſt raiſed in a ſmall bliſter on its fleſhy part, and then carried outward into a conſiderable length. It is in form a lengthened cone; hollow, and crowned at the extremity with a protuberant head.

ITS conic cluſters of Fibres, and the Pith, are all that remain to be conſidered; for tho' it receives nothing from the Pith or conic Cluſters in the body of the Root, there are ſuch cones of Veſſels in the Fibre, and there runs along its center all the way, a certain quantity of abſolute Pith.

WE have ſeen the firſt appearance of the Fibre was a bliſter on the fleſhy ſubſtance in the body of the Root. The Pith of the Fibre is no other than a matter thrown off from the outer ſurface of the Fleſh under the original bliſter, and is lengthened with the reſt of the parts into the entire Fibre. The conic Cluſters, which are original productions of the Fleſh in all parts of the Plant, are in the ſame manner formed in this.

THE Pith is formed as that in the body of the Root; and the plain manner wherein we ſee this done in the preſent part, confirms the doctrine with regard to the origin of the other. In fine, a Fibre of a Root is no other than a long proceſs of the body of the Root itſelf, increaſing the ſurface to draw more nouriſhment. Fig. 18, is a longitudinal ſection of the ſame Root repreſented at 17, with the new Fibres more advanced in growth; at 16, e, is a Fibre yet longer: and at Fig. 23, is a ſplit Fibre, with a piece of the Root magnified.

CHAP. XII.

Of the ASCENDANT SHOOTS.

THE body of the Root, in its courſe of growth, at the ſame time that it puſhes out Fibres from the ſides and lower part, ſends alſo from the upper part, or crown, ſhoots which are to furniſh Stalks and Leaves. The origin and ſtructure of theſe are yet to be examined: and we ſhall then have cleared the Root, and may advance to the body of the Plant, its Leaves, and its Fructification. This part of the Root, and the origination of Stalks and Leaves from it, may be conſidered in two views, as they appear two ways in Nature: 1. As the Germ, or Bud for a future Plant, is placed on the abſolute crown or ſummit of the Root, 19, a; and

2,

2, as a ſhoot or proceſs of the Root, is formed for it, ſeparating from the body of the Root at a greater depth, and bearing the Germ upon its head, 19, b c. The Stalks and Leaves of Black Hellebore are produced both theſe ways; and the latter, as moſt analogous to the formation of the Fibres, will demand the firſt conſideration here.

THE origin of one of the aſcendant flowering Shoots is this. The Root being filled with nouriſhment, and able to ſupport more Leaves and Stalks than thoſe which riſe from its immediate Crown, a proviſion is made by Nature for more Heads, and more Crowns from below. The fleſhy ſubſtance of the Root riſes into a bliſter within its other coats, either near the top, 19, b, c, or at, perhaps, two thirds of its length or depth in the ground, d. This is exactly like thoſe bliſters which gave origin to the Fibres, only it is larger; and is directed upwards: it ſwells out in the ſame manner; and firſt forms a lump upon the ſurface of the Root. This grows from time to time larger and longer; and inſtead of making its way downward, as the Fibre did, keeps the direction upward. It reaches to the ſurface, or nearly ſo, and there it terminates. A Root of Hellebore with ſuch a proceſs, full grown, is repreſented entire at Fig. 20, and ſplit at 21, where is alſo ſhewn a Fibre tending downwards.

THIS diſſection ſhews the Shoot to be exactly like the Fibres in ſubſtance but not in termination. All the coats of the Root are continued up the whole length of this proceſs; and a Pith ſoon ariſes from the fleſhy ſubſtance at the baſe of the bliſter, 21, a. The fleſhy ſubſtance forms an arch or vault juſt under the crown of this Shoot; returning into itſelf as in all other parts: but the coats do not return upon themſelves in that manner. They terminate abſolutely in the head of the Bud, and there form the firſt rudiments of Leaves and Flowers; every coat terminating in ſome one part. Thus we ſee the fleſhy ſubſtance of the Root is one continuous body, ſurrounding it entirely; and is diſtinct in the body of the Root, tho' in part continued into the Shoots and Fibres.

THIS is the plain and ſimple formation of the aſcendant Shoot or proceſs of the Hellebore for flowering. The Head or Crown of that Shoot forming the rudiment of the future Plant, is conſtructed thus.

THE outer Bark of the body of the Root being continued to this proceſs, ends in certain Scales at its top; ſee Fig. 22, which is ſomewhat enlarged, Letter a. Theſe are the Scales a, in the principal Figure terminating 24, alſo the outer Rind there; the inner Rind terminates in certain other Scales, b, which are to be the outer Petals of the ſucceeding Flower. Cloſe within theſe we ſee in the Crown the Vaſcular Series, 22 c, which

is

is very difficultly diſtinguiſhable in theſe longitudinal ſections of the Root itſelf. Within this part, in the ſplit Crown, appears a portion of the fleſhy Subſtance, but not the whole, 22 d. The principal part of this ſubſtance makes the vault or arch by which it returns upon itſelf, and makes the entire communication round the Root; but a proceſs of it riſes in this Crown as a Bliſter; juſt as in the origin of the Shoot itſelf; and is continued into the Germ or Bud upon the ſummit. There it does not return into itſelf entirely, or form an arch of the whole; but a part is again ſent off, and terminates like the outer ſubſtances, in many threads, which end in the future Filaments. Within this is a green line, which is a part of the conic Cluſters, f; and finally a Pith is raiſed under this Bliſter as under the others, and this extending itſelf in length, terminates alſo in the rudiments of the Seed Veſſels, 22, g. Thus is the Bud of Black Hellebore formed; and this as ſoon as formed, is defended by many Scales ſeparated from the three outward coverings. This being underſtood, the formation of a Bud at the head, or proper crown of the Root, is known, for it is the ſame with that of the Crown in this.

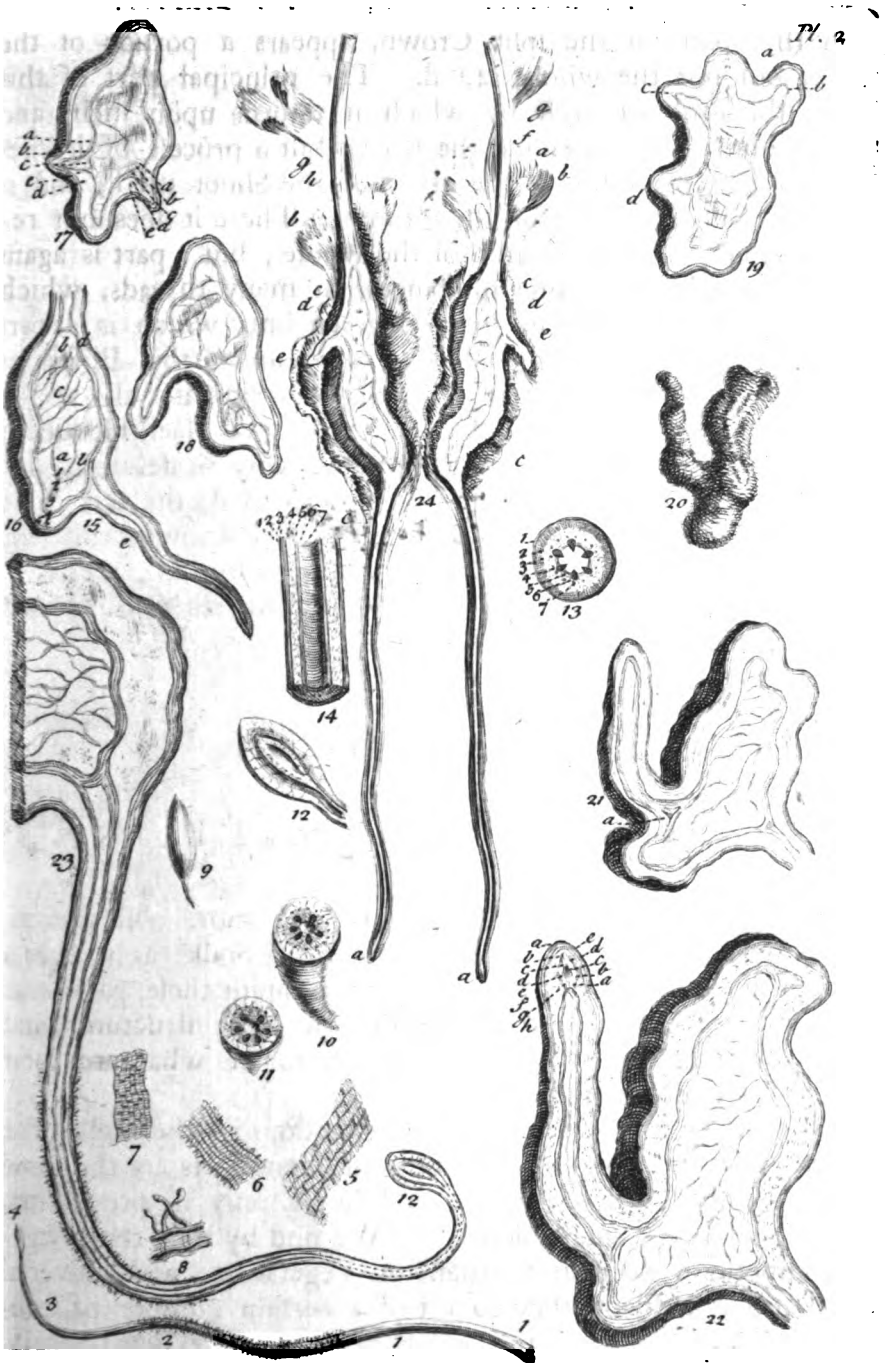
We ſee of what parts the Root is compoſed; and we are now to examine the entire Plant.

CHAP. XIII.

The CONSTRUCTION of the ENTIRE PLANT.

THE rational courſe will be, firſt to confirm, by more obſervations, what and how many are the conſtituent parts of a Stalk, as well as a Root, and Fibre, by tranſverſe ſections; then to ſeparate theſe parts one from another by maceration; and thus enquire into their ſtructure: and finally, by longitudinal ſections of the freſh Plant, to ſee what are their connections, and how one is united to another.

THE firſt diſcovery we make by the tranſverſe ſections of the Stalk, the Fibre, and the body of the Root, is, that the conſtituent parts are the ſame in all of them in number and conſtruction: differing only in proportion. And this is a diſcovery of no ſmall moment. We find by this, that Vegetables have a compoſition peculiar to them as Vegetables; and univerſal among them: that it is as Plants they conſiſt of a certain number of conſtituent parts; and that, as among the ſeveral portions of a Plant, Stalk, Root,



Construction of the Root.

Root, and the like, the only difference is, in the proportion of theſe conſtituent parts to one another, ſo it is alſo in regard to the greater difference of one ſpecies from the reſt.

A CERTAIN number of conſtituent parts, therefore, are found in all Vegetables, and in all the perfect parts of every Vegetable. Theſe the ancient philoſophy held to be only three; the Bark, the Wood, and the Pith: later reſearches increaſed the number to five, accounting two Barks, the Blea, the Wood, and the Pith. To theſe, the obſervations it has been my fortune firſt to make upon this ſubject, have added two; increaſing the number of conſtituent parts to ſeven: and if we add the membranes which incloſe theſe ſeveral portions, the account will run much higher.

THE two parts I have found, and which had eſcaped the obſervation of others, are a Vaſcular Series between the Blea and the Fleſh of Plants which laſt is the part analogous to the Wood in Trees; and an aſſortment of conic cluſters of Veſſels, taking their origin within the inner ſurface of the Fleſh, and pointing inward into the Pith.

THEREFORE accounting the conſtituent parts of a Vegetable Body, they are, as we have before ſeen in the Hellebore Fibre, ſeven; and they are diſpoſed in this order.

1. A THIN brown outer Bark. 2. An inner Rind, green, and much thicker. 3. A Blea, white in colour, and many times thicker than both. 4. A Vaſcular Series, or ſingle courſe of Veſſels, of a deep green, incloſed diſtinctly between two membranes. 5. The Fleſh of the Plant, of a yellowiſh green. 6. The conic Cluſters of Veſſels, of a mixed green and white colour. And 7. the Pith perfectly white.

ALL theſe parts are ſeen diſtinctly in the ſections of the Fibre, the body of the Root, and the Flower Stalk; ſections of all which are given in Plate III. all theſe parts being portions of the entire Plant, proceeding from the Root to the Fructification. In the Stalks of the Leaves we ſee fewer; their ſimple office being only to imbibe moiſture from the air, and to exhale the redundance of it at other times, for the nouriſhment of the Plant, and due motion of its Juices. Theſe are therefore to be accounted only as a kind of appendages to Plants; nor are they of abſolute neceſſity, for ſome kinds live without them: to the others all the ſeven conſtituent parts are neceſſary, becauſe from them riſe, in a plain and certain courſe, the Flower and Seeds.

THE Figures 25, 26, and 27, repreſent three tranſverſe ſections, or thin ſlices, of a Fibre, as they appear before the Double Microſcope. 25 Is a ſection taken from the naked upper part of the Fibre near the body of the

Root. 26 Is a ſection cut out of the middle part of the Fibre, where it is hung about with Fibrills in form of Hairs. And 27 is cut from the plain and tender part toward the extremity. The ſeven conſtituent parts are equally preſent in all theſe portions of the Fibre, only they are leſs diſtinct where it is tendereſt and moſt juicy toward the extremity, as at Fig. 27.

ADVANCING from the Fibre to a ſection of the body of the Root, we ſee all the ſame parts, and have them more diſtinct, as the ſubject is larger: and there we have the firſt inſtance of that difference they ſhew in the ſeveral portions of the Plant, beginning with a variation in number. In a tranſverſe ſection of the body of the Root, cut extremely thin, and viewed before the Double Microſcope, with its ſmaller powers, we ſee all the ſeven parts diſtinctly, as repreſented Fig. 28. Each has its regular place, and regular proportion to the others; but the conic Cluſters are doubled in number. They were only ſix in the Fibre, but here they are twelve. In the Flower Stalk the parts are ſtill the ſame, but they differ in proportion; the Blea is leſs in quantity, and the conic Cluſters are there twenty-four. This is repreſented, moderately magnified, at Fig. 29, and largely and diſtinctly at Fig. 30. What remains is only to trace the parts in the Footſtalks of the Leaves.

AT Fig. 31. is repreſented the body of the Footſtalk in a tranſverſe ſection magnified, which conſiſts only of an inner Rind and Blea, with twelve of the conic Cluſters; and at 32, is repreſented a like ſection of one of the diviſions at the top, in which are only four of the twelve Cluſters, a regular portion being ſent into each of thoſe parts.

WE are about to trace the courſe of theſe ſeveral conſtituent parts thro' the Plant, in the ſucceeding chapters; nor will this be difficult to an attentive eye, becauſe they continue the ſame in all the portions of the Plant, whether they are continuations one of another, as the Rinds, &c. or generated in the part where they appear, as the Pith: but one thing is ſeen plainly in theſe ſections, which demands enquiry here: this is the variation of the conic Cluſters in number.

IT would be natural to ſuppoſe, that the ſix of the Fibre were continued into the body of the Root, and were there divided; and that the twelve of the Root became, in the ſame manner, the twenty-four of the Flowerſtalk: but if this were the caſe, there muſt be many times twelve in the Root, for there are many Fibres; nor could the twelve we find there furniſh the four and twenties of the ſeveral Flowerſtalks; for they are very numerous from one Root. This is the Problem; and in a diſcovery ſo new,

new, nothing muſt be regarded but plain obſervation. It will be neceſſary to the underſtanding Vegetation, to trace theſe conic Cluſters very carefully, for their office is important, nor was it poſſible the Growth and Life of Plants could be underſtood while theſe remained unknown.

TRANSVERSE ſections of the parts ſhew the place and diſpoſition of theſe cluſters, but 'tis in the ſplit Roots we muſt trace their origin. To this purpoſe chuſe a ſound Root of Hellebore; ſplit this perpendicularly down, and chuſing a part for obſervation that has a Fibre growing from it, cut away the reſt: then ſplit this piece again, ſo that the knife may paſs thro' the middle of the Fibre, and ſplit that alſo down ſome part of its length, cutting off the one half by a perpendicular ſtroke. Such a piece of the Hellebore Root is repreſented Plate III. Fig. 33. and it is the only kind of ſection in which we can trace, in one view, the courſe of theſe cluſters of Veſſels in the Fibre, and in the body of the Root, ſo as to ſee what connection there is between theſe conſtituent parts, in diſtinct portions of the Plant. Such a ſection is repreſented Plate III. Fig. 33. The different faces in this figure all ſhew diſtinctly the ſeveral conſtituent parts of the Plant; and we ſee at Letter *a*, in what manner the ſame parts, namely the conic Cluſters, and Vaſcular Series, are diſtinguiſhed in a tranſverſe ſection, which at *b* are ſcarce to be diſcovered in the longitudinal diviſion, becauſe they appear there only as a kind of Fibres running the ſame courſe with the reſt of the parts.

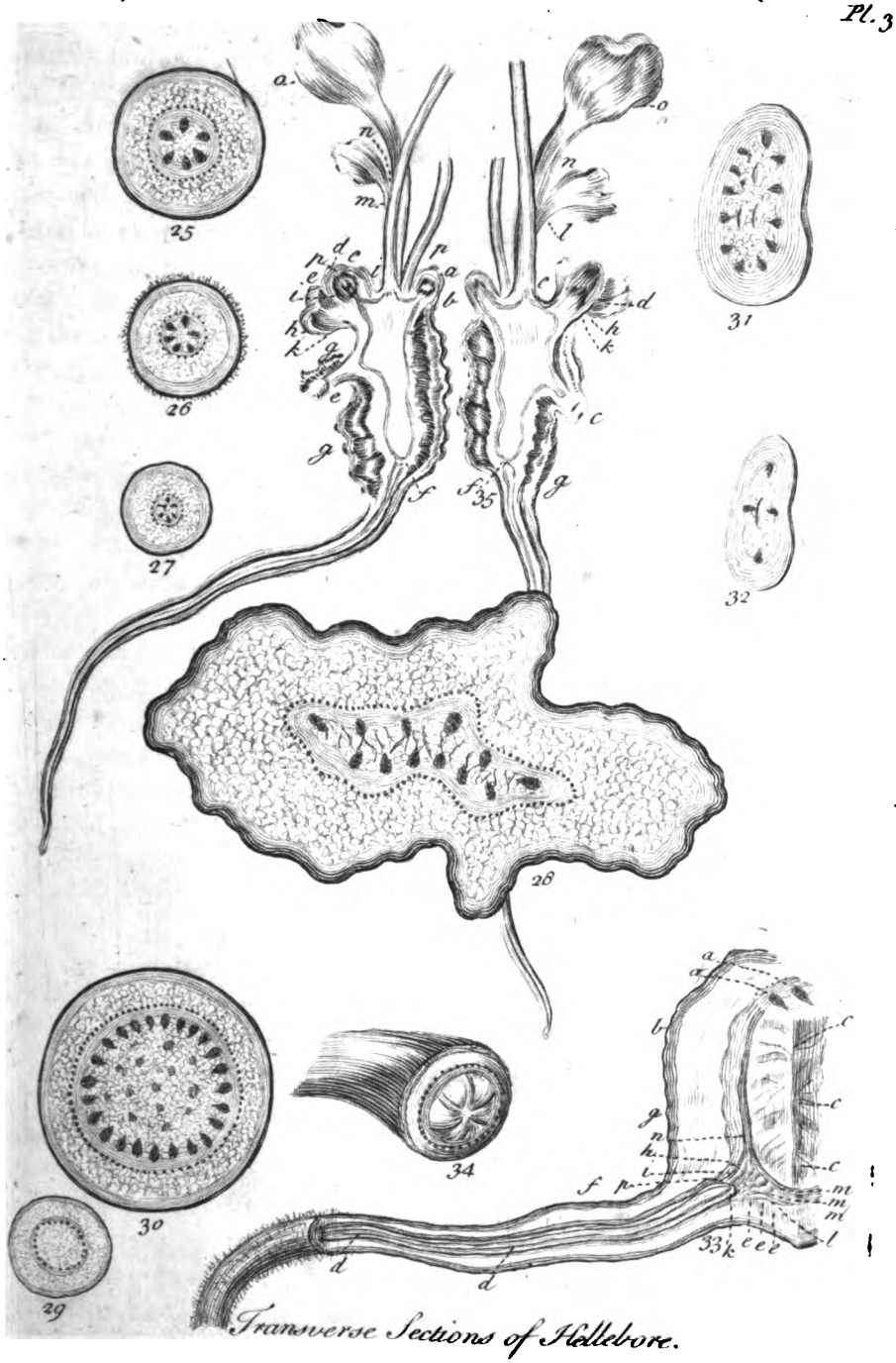
WE ſhall find, in tracing the courſe of the other parts in the purſuit of this ſubject, that the Fleſh of the Plant does not run entire from the body of the Root into the Fibres; but the principal part of it purſuing a plain courſe round the Root, a portion only is ſent off from its ſurface to form the Fleſh of the Fibre. Therefore, in the body of the Root there is an hollow for holding the Pith, *c c c*; and in the body of the Fibre there is another, *d d d*. Theſe two hollows we ſee do not open one into the other; for this ſection is made thro' the very center of the Fibre; and all that thickneſs of the Fleſh of the Plant repreſented at *e e e*, has its place between them, nor is penetrated by any hollow whatſoever. Now the place of the conic Cluſters of Veſſels is always within the Fleſh of the Plant, as appears in all the tranſverſe ſections of this Plate. Therefore the maſs of impervious Fleſh marked *e e e*, being between the cluſters of the Fibres and thoſe of the Root, they cannot be abſolute continuations the one of the other, any more than the Pith of the Fibre and the Pith of the Root. Their ſituation is as diſtinct as their number.

WHAT is the abſolute courſe of theſe Cluſters in a Fibre at its extreme termination, we have ſeen; they are continued in arches round that extremity, returning upon themſelves, as has been repreſented Plate II. Figures 10, 11, and 12. It remains to find in what manner they terminate at the top of the Fibre, where it is joined to the Root. To know this we muſt take off the Fibre *f*, from the body of the Root *g*, at the part *h*, not ſtrait down tranſverſely thro; but by an arched ſtroke, ſuch as is marked by the dotted Line *i k*. It will be more proper to cut out an entire Fibre than one which is ſplit, for this obſervation; but the divided piece of the Root 33, ſhews exactly where the knife is to paſs. Many trials will fail; for it is eſſential to cut juſt under the arch made by the Fleſh of the Fibre, without wounding the Veſſels themſelves; but with attention it may be executed; and if a Root be choſen for the purpoſe which has been a little while macerated in water, if ſome fragments of the Fleſh remain on the top, a ſmall pencil working in water, will get them off, and ſhew the courſe of the Veſſels entire. We ſhall thus find that the conic Cluſters of the Fibre not only do not run into the body of the Root, but that they never enter the Fleſh at all; they return upon themſelves in ſo many arches, juſt within the vault *e*, made by the Fleſh of the Fibre, and conſtitute, as it were, another diſcontinued ſhell within that, ſurrounding every where the Pith. At Fig. 34. is repreſented the head of a Fibre, taken from a Root which had been ſome ſmall time macerated in water, in which the ſix broad and arched lines are the conic Cluſters preſerved entire.

WE ſhall ſee in the ſucceeding chapters, that theſe Cluſters of Veſſels are, in the ſame manner, diſcontinuous between the Root and Stalks: but there is yet one obſervation which the preſent ſection of the Root offers, and which muſt properly find its place here.

ALTHO' the conic Cluſters in the Fibre are not continuations of thoſe in the body of the Root, there yet is a communication between them; and perhaps what thus is ſeen in the perfect Fibre, as a communication only, was originally the ſource of thoſe Veſſels.

ON cutting off a very thin ſlice of the part of the Root, Fig. 33. *e e e*, which is the maſs of the Fleſh of the Plant, between the Root and Fibre, and laying it in water before the Double Microſcope, we perceive certain thick white lines, running a courſe contrary to that of the Veſſels which compoſe the Fleſh, and interwoven, as it were, among them; beſide the multitude of theſe threads which muſt have been cut aſunder in various angles, we ſeldom fail to ſee ten or twelve very conſpicuous and entire, in



Transverse Sections of Hellebore.

the thinneſt pieces. They are repreſented in Fig. 33. at *m m m*. In any of theſe which are cut entire, we may trace the origin and inſertion, as well as the whole courſe. In that part of the thin piece which has been a portion of the body of the Root, if we have been ſo happy as to cut thro' one of the Cluſters, we diſtinguiſh a ſmall line between the Fleſh and Pith, of a mixed dark and pale colour. This is repreſented at Letter n, and its termination at *o*, ſhews that it is a longitudinal view of one of thoſe Cluſters; this ſection having been made ſo as to take the courſe of one of the twelve great Cluſters juſt within the ſurface, the variety of colour is owing to the different coloured Veſſels of which each of theſe Cluſters is compoſed.

FROM one or other of the green Veſſels of this Cluſter ariſe all thoſe white lines which pierce the ſubſtance of the interjacent Fleſh, and make their way to the Cluſters of the Fibre, where they form the vault or arch *p*, at the head. Being white, it would be natural to imagine they aroſe from the white Veſſels of the Cluſter; but palpable obſervation ſhews it is otherwiſe. I have ſometimes thought I could diſtinguiſh a green thread in the middle of each. If it be ſo, they have only thick white coats, but carry the rich green Juice of the Cluſter. The Fleſh of the Plant gives paſſage to thoſe Veſſels, and as they proceed from the Cluſters of the body toward thoſe of the Fibre they unite two, or more, into one larger; and in this enlarged form they are plainly inſerted into the Cluſters of the Fibre. Probably this is the origination of the Cluſters in the Fibre, and in theſe arches at the top of the Fibre the Cluſters properly begin, being produced by the united branches of thoſe ſmall white Veſſels from the Cluſters of the body, and naturally enough extending themſelves along each way, between the Fleſh and Pith of the Fibre, till coming to the extremity they return in an arch, and reach the head again, where they began. This is the courſe of thoſe Veſſels in all the Fibres; and the Letters *e e*, *f f*, in Fig. 35 of this Plate, which repreſents the entire Plant diſſected, diveſted of its outer Rind, and with the inner ſeparated, and ready to be taken off, ſhew part of the very ſame conſtruction with *b i l* in the Figure 33, only not enlarged enough to appear diſtinctly.

CHAP.

CHAP. XIV.

Of the COURSE and CONSTRUCTION of the OUTER BARK.

FROM this view of the place, and diſpoſition of the ſeveral conſtituent parts of this Plant, we may proceed to trace their courſe and terminations; and afterwards their conſtruction. The courſe and termination of the ſeveral parts can be truly known but one way, which is by ſeparating each part from the reſt, without tearing, or otherwiſe injuring it, This is a tedious and delicate operation; but it is not impracticable. The purpoſe is, to ſeparate one by one the ſeveral coats and conſtituent ſubſtances of the Plant, beginning with the outermoſt, and working inward: this is not to be done in the entire Plant, nor while it is freſh and growing; he who ſhould undertake ſuch a taſk, would attempt what is impoſſible; but with the help of maceration, and a proper diviſion, it may be effected. I ſhall direct others according to the method by which I have ſucceeded.

IN the mouth of January take up a Plant of Black Hellebore in Flower, getting it out of the ground entire. Waſh away the mould from the Root, and laying the whole Plant lengthway upon a board, cut it acroſs into ten parts. Each part will conſiſt of many pieces of the Plant, but they will be all pieces of the ſame general portion of it. Thus the firſt parcel, counting from the bottom, will conſiſt of a number of ends of Fibres; the ſecond will conſiſt of pieces of Fibres cut from a little higher; and ſo on. Let there be ready ten earthen pans, with about a pint of water in each; and mark them 1, 2, 3, and ſo on to the tenth. Into the Pan marked 1, put the firſt parcel, and the others, in a regular order, one parcel into each pan. Then tye a paper looſely over each, and ſet them by to macerate. Thus there will be a number of pieces of every part of the Plant for experiments; and by laying together one piece out of each pan, in the order wherein they are numbered, we may at any time make up the whole Plant. It was from pieces of this kind that I obtained all the preparations which confirm the following experiments. Different time will be required for the maceration of the ſeveral parts; therefore the experiments upon them ſhould be often repeated: for what does not ſucceed in one ſtate of maceration, will in another. The outer Bark is the

firſt part to be taken off, and we muſt begin with the body of the Root, becauſe this coat is there moſt perfect, and was the original Bark of the Seedling Plant, the Fibres and Stalks, with their Bark, having been produced from it.

FASTEN a flat piece of cork with ſome cement, ſuch as Cutlers uſe, to the bottom of a white ſtone plate; fill the plate with very clean ſoft water, and here begin the ſeparation. Take one of the pieces out of the pan which contains ſome of the body of the Root. Waſh the piece clean: ſplit it down the middle, and lay one of theſe parts, with the ſplit part upwards, upon the cork in the plate, and fix it with a couple of needles: I have fine needles faſtened to long handles for this purpoſe. Then examine the edges with the help of a ſmall magnifier, and there will be ſeen ſome places where the outer Bark is leſs firmly united to the inner than in others; theſe are a kind of openings made by the diſſolution of the thickened Juices which had lain between the two Rinds; and having been ſeen with the glaſs, they will afterwards be more eaſily diſtinguiſhed by the naked eye. Introduce the point of one of the hooked and edged needles into one of thoſe openings, and then working gently between the two Rinds, the outer may be ſeparated from the inner; and by purſuing this method with pieces from the other pans, we may thus obtain the outer Bark of the entire Plant ſeparated from the other parts. We are not to expect that we can get this entire even from the moſt favourable pieces; but in how many fragments ſoever it is got off from the Plant, theſe being put together, ſhew us its whole courſe; and thus we know how much of the Plant it covers, and in what manner.

THE outer Bark of the Hellebore thus ſeparated, and laid together in form, is repreſented in Plate II. Fig. 24. and thus we ſee its whole courſe on the Plant.

THE original outer Bark, is properly the covering of the Root, and nothing more. It extends from the extremities of the Fibres *a a*, to the ſurface of the ground *b*; but toward the top it ſuffers ſome change. From the extremities of the Fibres to the top of the Root, where the Stalks riſe, it is of the ſame uniform texture and colour, thin and brown; but from the crown of the Root upwards, it becomes greeniſh, and is ſomewhat thicker, making a kind of ſhell for the outermoſt defence of the Bud *b c*. Great care muſt be taken in getting off the Bark from the Root juſt at the Crown, the part marked *c*; for it is very tender, and eaſily breaks there; but being taken off with care, we find the greeniſh part is abſolutely continuous with the brown, and is its extreme termination.

THE

THE outer Bark of the Hellebore Root, therefore, covers it with all its Fibres, from the ſurface of the ground to their extremity, there rounding them without any breach or aperture, ſo that when ſeparated from the reſt, it may be compared to a glove, with numerous, long, and very ſlender fingers; but with no opening, except at the top.

THIS is the original outer Bark of the Hellebore, which is confined to the Root; but there is alſo a ſecondary one, which covers the Flowering Stalk. This Stalk firſt riſes without any outer Bark, the inner Rind of the Root being its natural covering. This is repreſented in the Figure 24; the inner part of the Root being left within the ſeparated outer Bark for that purpoſe, *e e e e*. We ſee here the green inner Rind making regularly the outermoſt covering of the Stalk, the other terminating at *b b*, having covered that part of the Plant which was under ground: but the part f f, tho' it roſe naked, does not continue ſo: a new outer Bark is formed for it from its own extravaſated Juices, hardened by the air; and this covering the two Films *g g*, terminates there entirely. Thus there are properly two outer barks of the Hellebore, formed for the protection of the different parts of the Plant, and having their ſeparate terminations; that of the original outer Bark being at the ſurface of the ground, that of the ſecondary one at the upper Film of the Flowering Stalk. Theſe two Films originally fall over one another, and cover the Bud of the Flower; and thus the outer Bark, till the Flower opens, forms an entire covering for the Plant.

CHAP. XV.

The CONSTRUCTION of the OUTER BARK.

HAVING ſeparated this outer covering of the Plant in a number of pieces, any one of theſe may be uſed for enquiring into the ſtructure of the part; and there is little difference from whatever part it is taken, but it is moſt perfect on the body of the Root: this was the original part, the Fibres, and the Flowering Stalks having been produced from it: therefore in this it is beſt to ſeek its fabrick there: and by tracing it regularly in this, and comparing it occaſionally with the outer Bark of other Plants, we ſhall not only diſcover the ſtructure, but the uſes of the part.

ONE

ONE of the ſmall pieces of the outer Bark being laid in clean water, and rubbed over gently with a pencil, to waſh off all accidental foulneſſes, or remains of other parts, is in a condition for this examination. It is to be laid in a drop of water upon a plate of glaſs, and viewed with a very powerful magnifier. It thus appears a kind of net, with large irregular meſhes; of a browniſh colour; what reſemble the cords of the net being browner than the reſt. Whether we lay it with the outer or inner ſurface upwards, it has the ſame appearance. We perceive the meſhes are not open; for in that caſe the interſtitial part would be colourleſs; but on which ever ſide we view them, we diſcover that they are filled up by a membranous matter. A piece of the Bark thus appears as at Plate IV. Fig. 39. And examining the edges of the piece, we ſee very plainly this membranous matter, between the abrupt ends of the ſeveral Veſſels *a a a*.

TO examine the ſtructure farther, let the piece be faſtened upon a cork in water, and with a fine pencil work round all the edges, rubbing from without toward the center. By this means I have ſucceeded ſo far, as to ſeparate the parts of which this Bark conſiſts. Applying more power of magnifying, and laying a ſmall piece of the Bark thus divided, with the outſide upwards, we find that it is compoſed of two membranes, and a multitude of delicate Veſſels laid between them. The outer membrane is yellowiſh, the inner whitiſh; and the Veſſels are of a deep brown. As the two membranes naturally ſhrink when they are thus ſeparated, the ends of the Veſſels ſtand out in ſome places beyond them; and it is eaſy to perceive their mouths in thoſe extremities. A piece of the Bark thus magnified is repreſented at Fig. 37. The Membranes are mere Films: the Veſſels run upwards in a winding courſe, and are full of inoſculations, joining with one another in innumerable places. They appear uniform and regular in their ſtructure, except that they ſwell a little in ſome parts, and principally near the joints where they unite one with another. They are extremely ſlender; their colour is a yellowiſh brown, and they are paleſt where fulleſt of juice.

THE inner ſurface of this Bark remains to be examined; and for that purpoſe it will be proper to put on the very largeſt magnifiers. I am particular in the uſe of the Double Microſcope, and combine upon theſe occaſions two object glaſſes, by means of a larger tube which ſlides upon the tube of the Microſcope: at the end of this I place a lens in one of thoſe poliſhed ſhells which are contrived for the Single Microſcope for opake objects. This is brought before the common object glaſs of the Microſcope; and we have their combined powers. There is ſome difficulty in

fixing the place where the image from the firſt lens is beſt received by the ſecond; but not ſo much as might be expected; when the two are properly placed, altho' they be ſeparately but of moderate power, they exceed the firſt magnifier in the common way by many degrees, when thus united, and there is a larger area and good light; the ſhell of the loweſt object glaſs very happily reflecting the light from that below.

A PIECE of the Bark laid with its inner ſurface upward, and managed as the other to ſeparate the two membranes, makes before this great power of magnifying a very curious appearance. The membrane now thrown back is the white one; and we ſee it, both where it is looſe, and where it yet adheres to the Veſſels and to the other membrane, pierced with innumerable minute holes in different places, but principally near the Joints, and at thoſe other parts where the Veſſels ſwell. The piece of Bark thus magnified is ſhewn at Fig. 38; and the holes in the white membrane at Letter *a a a*.

IF we now turn the piece of Bark, we ſhall find the yellow membrane which made its outer ſurface, is no where pierced in the leaſt; ſo that theſe apertures are peculiar to the other. Examining the Veſſels with this great power of magnifying, we perceive certain parts upon their ſurface which have a correſpondence with theſe holes, and ſhew their uſe. At the joints of the vaſcular net, or thoſe parts where the Veſſels inoſculate with one another, b, as alſo in the croſs-arched bars which unite them, *c c c*; and in whatever part theſe Veſſels ſwell, as at d d d, we perceive a roughneſs and irregularity of ſurface in them, not ſeen in other places. To diſtinguiſh what this is, we muſt uſe various degrees of light, and various poſitions of the object. There is ſcarce a more delicate thing among all the microſcopic ſubjects. But with attention and unwearied trials, we ſhall at laſt ſee theſe parts of the Veſſels in lights proper to ſhew to what their roughneſſes are owing.

IN all theſe places the coats of the Veſſels are pierced with many minute holes, much ſmaller than thoſe in the membrane with which they correſpond; theſe holes in the Veſſels are all round fringed with a number of minute yellowiſh hairs, which form a kind of pencil, whoſe point pierces the hole in the membrane oppoſite to it.

As there are no ſuch holes in the yellow or outſide membrane, ſo neither are there any viſible apertures in the outer ſurface of the Veſſels; only toward the extremities on the Plant they are entirely ſpungy. What may be the uſe of theſe ſingular apertures on the inner ſurface of this Bark, it is too early yet to ſeek; if the examinations of the other parts ſhew

ſhew us their ſtructure diſtinctly, perhaps it may be known when we view all together. Only this we may obſerve at preſent, that here is a proviſion of Nature for diſcharging ſome of the juice from the Veſſels of the outer Bark, into the interſtice between that and the inner, without the waſte of any between the two membranes of the Bark itſelf. We ſee alſo the means by which theſe two coats of the Plant are faſtened one to the other, and how maceration acts in procuring their ſeparation.

THESE hairy fringes, which ariſe from the Veſſels of the outer Bark, faſten themſelves to the outer ſurface of the Rind under it; and as they are innumerable, and riſe from ſo many and ſo near parts, they hold the two together through their whole ſurfaces: but as they are very tender, they are the firſt things that diſſolve on lying long in water; and the band of union being deſtroyed, they ſeparate.

THIS Conſtruction of the Veſſels of the outer Bark, explains alſo how it is that in the growing ſeaſons we find a looſe fluid between the outer and the inner Barks of certain Shrubs and Plants. In the Mezereon I have obſerved this particularly in early Spring; and it is evident in the Stalks of all the Bulbous Plants.

AT Fig. 39, I have endeavoured to ſhew the manner wherein the two Barks are united in the Body of the Root of Hellebore. The Figure repreſents a ſmall piece vaſtly magnified, as it appeared under the poliſh'd ſhell and double object glaſs. *a* is the outer, b the inner Rind, ſeparated by the needle, and curling backwards, as they do immediately on the ſeparation. *c c* are the parts where the fringes of the mouths of the Veſſels of the outer Bark faſten themſelves to thoſe of the inner.

AT Fig. 40, is repreſented a portion of the vaſcular part of the outer Bark, ſeparated from its membranes: and as there is ſome ſmall difference in the courſe of the Veſſels in the outer Bark of a, the flowering Stalk, from that in the body of the Root, a ſmall piece of the Bark taken from the lower part of a Flower Stem of the Hellebore, is repreſented at 41; and the Veſſels enlarged, and taken out from the membranes, at 42. The courſe of the Veſſels is ſtraiter in the Stalk, from its length and ſlenderneſs, than in the body of the Root; and their croſs-bars are leſs arched: indeed they are nearly horizontal; but the conſtruction is the ſame in both. Theſe have the ſame mouths, with the ſame fringes round them, and there are in the inner membrane the ſame perforations.

THIS is the conſtruction of the outer Bark of Hellebore. Knowing this, it will be proper to examine whether the outer Barks of other Plants re-

ſemble it. We ſeek, by theſe experiments, the laws of Vegetation, and the Philoſophy of Plants; and they are not to be determined from what we ſee in a ſingle ſpecies.

To render the obſervation eaſier, it will be proper to view the others with the ſame magnifying powers, and to take them as nearly as may be from the ſame parts of the Plants; therefore, as there is conſiderable difference in the ſhape of Roots, and as we ſee the courſe of the Veſſels is ſomewhat altered by that ſhape, altho' their ſtructure be the ſame, it will be beſt to fix upon the Bark of the Stalk in each kind, taking it off always near the bottom.

As Roots are thicker, the meſhes of the reticular courſe of Veſſels are wider, as in 36, 37, 38, and in conſequence the croſs-bars become arched by the force which ſeparates the Veſſels thus far aſunder in the ſides of the meſhes; but in Stalks, as there is one general form from which they never vary much, that is, a ſlender cylinder, the courſe of the Veſſels will not be ſubject to thoſe innumerable variations which the different forms of Roots occaſion.

It was convenient firſt to trace the conſtruction of this part, in pieces taken from the body of the Root, becauſe it is there original, and the Veſſels, and their mouths, are both much larger than in any part above ground: but there is equal reaſon for chuſing the Bark of the Stalk for the object of compariſon with that of other Plants, becauſe being free from thoſe accidental variations which the ſhape of the root gives, there will be no confuſion in the enquiry; no accidental differences will be ſeen, and we ſhall therefore purſue more diſtinctly the real variations or ſimilitude. The piece of the outer Bark of the Flowering Stalk of Hellebore, 41, ſhews that conſtruction and diſpoſition of the Veſſels, with which we are to compare thoſe of others. The Veſſels in this run nearly ſtrait, at tolerably regular diſtances; and the bars by which they inoſculate one with another, are placed at a conſiderable diſtance, and diſpoſed nearly at right angles with the others. The fringed mouths in theſe are very minute, and are placed principally at the joints, and in the croſs-bars.

In the outer Bark of the Anemone the Veſſels are much thicker, and the croſs-bars very ſlender; in theſe the mouths are placed at ſmall diſtances all along the inner ſurface of the longitudinal Veſſels, and the croſs-bars ſerve merely for communication between one of the aſcending Veſſels and another; they are ſo ſlender that they appear as mere Fibres; and their cavities are inconceivably ſmall.

The

THE Pulſatilla, which comes next in this gradation, ſhews that theſe bars are not of abſolute neceſſity to the uſe of this part; for in its outer Bark there are none. The Veſſels are large; they are placed much nearer to one another than in the Hellebore; and they have no communication one with the other. I have traced a ſingle Veſſel from the bottom to the top of the Stalk, and found it no way, nor no where, joined to the reſt. Theſe Veſſels have their opening inward, as in other outer Barks; but it is in a manner very different from the former. The juices they convey are thicker and more coloured than in the generality of other Plants; and there are at various diſtances in all the Veſſels a kind of Glands, at which they ſtop: theſe are darker than the reſt of the Veſſel, and ſomewhat ſwelled; and lengthwiſe of each ſwelled part, there is opened a ſmall ſlit, which has no fringe or hairyneſs about it. This ſlit pierces the inner membrane, and can diſcharge its liquor into the ſpace between this Rind and that next under it.

THE Stalk of the Pulſatilla is extremely hairy; theſe hairs are white tubes, riſing immediately from the ſurface of the Veſſels, and opening with a plain mouth into them.

IN the Polyanthous Primroſe, the Veſſels are diſpoſed exactly as in the Hellebore Barks, only the bars are ſmaller, and the openings are by round fringed mouths along the ſurface of the aſcending Veſſels. The Bark of this Primroſe comes off very freely, but it is difficult to get the outer one pure. The colour of the Stalk is owing to the inner Rind; for the outer Bark is perfectly colourleſs: this will ſhew whether the two come off together, for we never ſee the outer Bark alone, unleſs it be very thin and perfectly colourleſs.

THE outer Bark of the Narciſſus affords a much more pleaſing appearance: it is thin, perfectly colourleſs, and very diſtinct in the conſtruction. The Veſſels in this are very ſmall, and the fluid they contain is entirely watery; they are made into a kind of links, joining by the ends, and being thus united in pairs, there are alſo croſs-bars, as in the other Barks, but not between the two Veſſels of the ſame pair; theſe are joined only by the ends of the links: the croſs-bars go from the outſides of each of theſe Veſſels, to the outſides of the Veſſels of the next link.

WE trace the courſe and form of the Veſſels in this Bark very happily; for there are no apertures either in their ſurfaces or in the croſs-bars; no fringe of hairs to diſturb the view, nor coloured juices, irregularly lodged, to intercept it. The whole conſtruction is plain; and that communication Nature always makes between the Veſſels of the outer Bark and the interſtice

terſtice between that and the inner, is thus preſerved. At the joining of the links there are a kind of knots: not at every joint, but at every third, fourth, or fifth, ſo that in the whole they are very numerous. Theſe knots have their origin from an opening which is between the two ends of the two links; for they are faſtened to one another at the two edges only, and not throughout the whole part where they touch. From this opening in the center of the joint riſes a ſmall Cone; at the top of which is a long and very narrow ſlit; which is capable of being diſtended or contracted, according to the ſtate of the Plant. The inner Membrane is cut in the ſame form at every one of theſe ſlits; and the glandular ſwelling round the aperture, alone preſerves all the juices from being diſcharged this way: this ſerves the ſame purpoſe with the hairs in the other Plants; and in the ſame manner unites the outer to the inner Rind.

In the Hyacinth, the outer Bark is equally diſtinct and colourleſs. The Veſſels are ſlender, they are placed more diſtant than in the Narciſſus, and are joined to one another by croſs-bars, as in the Hellebore. The mouths by which they open into the interſtice of the two Barks, are glandular, and conic, as in the Narciſſus; but they are larger and fewer; and they do not riſe at the joints, but are the abſolute terminations of certain branches of the Veſſels. So that in this Plant, while the greater part of the Veſſels purſue their uninterrupted courſe upwards, others terminate at different heights, and in conſiderable numbers, in abſolute glandular heads, diſcharging their contents between the two barks, and fixing one to the other. Round each of theſe glands, as alſo round the others in the Narciſſus, and in all the Plants of this kind, there is continually ſeen a kind of bladder of a peculiar Juice. This is the liquor diſcharged from the Gland, which makes its way ſlowly at the minute openings of the inner Membrane; and it is evident, that the Juices thus diſcharged, have ſuffered an alteration in the Glands, for they are thicker and more coloured than thoſe in the Veſſels. Often theſe Glands appear to riſe from the Membranes themſelves; but there is always a communication with the Veſſels.

In the outer Bark of the Stockjulyflower, the Veſſels are large and branched; they run a leſs regular courſe than in any of the preceding; but they are joined by croſs Veſſels in the manner of bars, one to another, as all the reſt. At many of theſe joints, but not at all of them, there are round ſimple ſwellings; perforated by very minute and naked holes, which open into the interſtice between the two Rinds.

In the outer Bark of the Pervinca the conſtruction is very like that of the Bark from the body of the Hellebore Root: the ſubſtance reſembles a

net from the diſtance of the aſcending Veſſels, and the frequency of the croſs-bars: but theſe are notwithſtanding ſtrait, and not arched as in the Hellebore. The fringed openings are diſpoſed and conſtructed juſt as in the Hellebore.

In the Bark of the Black Currant they are in the ſame manner formed into a net of broad ſhort meſhes, but with ſomewhat arched diviſions: and the whole ſurface of the Veſſels on the inner ſide is pierced with ſmall holes, with a few fringed hairs about them.

The uniformity of Nature in the eſſential part of the conſtruction of theſe various Barks may ſhew there is one general form, and one certain office, in this part of Vegetables, which is alike performed by all, and for which it is in all Plants deſtined and ordained. From the extreme Fibres of the Root the Veſſels of this Bark carry up Juices, in a ſhort courſe, to that part in which they terminate, which is uſually the Cup of the Flower; in their way diſcharge part of their contents into the interſtice between the outer and inner Rind; which matter ſo diſcharged, has not the colour or conſiſtence of that carried along in the Veſſels; and therefore we may reaſonably ſuppoſe it is not diſcharged ſimply from their cavity, but paſſes thro' minute Glands ſeated at the orifices. Doubtleſs this once concocted aliment is received into the interior part of the Plant; not diſcharged to waſte. That theſe Veſſels receive more than they are deſtined to carry to the extremity of the Plant, is evident; for in thoſe ſpecies whoſe apertures are ſmall inward, hairs, as they are called, riſe outward on the Stalk, which are only ſimple tubes, diſcharging, during the heat of the day, a part of their Juice. So far as I have yet obſerved, where hairs are wanting, there are parts of the Veſſels which riſe ſpungy to the exterior ſurface, and ſtretch the Membrane till it cracks over them: theſe anſwer the ſame purpoſe as the hairs on others, in throwing off a part of the Juice; and they can alſo imbibe. I have tied up the bottom of a Narciſſus Stalk to the neck of the Flower, and ſetting only the entire arch in water, the Plant has been tolerably well ſupported: unopened Flowers have blown from this nouriſhment, and the general tuft of Bloom has laſted nearly as long as in thoſe which had the cut end of the Stalk plunged in the water.

CHAP.

CHAP. XVI.

Of the INNER RIND.

THE inner Rind is, in the generality of Plants, much thicker than the outer; and of a looſer texture: in the Hellebore Root it differs in colour conſiderably, as well as in proportion, being green, whereas the outer Rind is brown. Often the Stalks of Plants are coloured, and the red, in this caſe, appears ſuperficial; it is really in the inner Rind. The Polyanthus is a very familiar inſtance, in which, tho' the Stalk be highly coloured, its outer Rind is perfectly colourleſs. When we ſeek the origin of this inner Rind, we muſt trace it in the body of the Root; that having been the rudiment in the Seed, and its firſt production in the ground: from thence it is continued downward, over all the Fibres, and upward into the Flowering Stalks, and Footſtalks of the Leaves. In theſe laſt it is the exterior coat, for Nature has allotted them no outer Rind: in all the others it is covered by the outer Bark juſt deſcribed, ſo far as that part reaches on the Plant; but this is extended every where ſomewhat beyond it: therefore the Footſtalks of the Leaves are not the only part where we may expect to ſee it naked.

IN the Hellebore, when it has covered the body of the Root and Fibres, it aſcends with the outer Bark to the ſurface, having a very eſſential ſervice in the Crown of the Root. Its courſe is repreſented in Plate III. Fig. 35. where a ſingle Plant of the Hellebore is figured ſplit open, and diveſted of the outer Bark; the inner Rind being alſo ſeparated on each ſide from the ſubſtance next within it. This is its extent, and this its courſe: when it has nearly reached the ſurface of the ground, it loſes the ſtrong green colour it had in the body of the Root *g g*, and becomes whitiſh, *b b*; terminating, while the Bud is yet fixed upon the Crown, in a vault or ſhell, *a b*, covering ſuch another ſhell formed of the Blea, *d d*; within which reſts the Rudiment of the Flower, with its ſhort Stalk, *i i*, ready to be enlarged by heat and moiſture.

WHEN it begins to grow, the Bud forces itſelf upward with the Blea and burſts the ſhell formed by this inner Rind: the Bud then appears with a round head above it, as at *d*; and the termination of the inner Rind ſeems to be in a circle round it, as at *c c*. But this is an accidental and a forced termination; and the real courſe of the inner Rind is independant of

of it. The broken Shell fades down to the part *k*, where it began to riſe looſe from the Blea; and the inner Rind puſhing upward from that part, not only gets a new outer Bark for itſelf, but follows the courſe of the Blea upward in the aſcending Stalk.

We have ſeen that there was originally alſo a ſhell of the outer Rind over the Bud at the Crown of the Root: this and the ſhell of the inner Rind being both broken, there remains only the third ſhell or Blea over the young Flower, which is formed of the Fleſh of the Root. As it riſes higher this third ſhell aſcends with it: where it ceaſes we ſhall preſently ſee; but now, aſcending entire, the power of growth being ſtrong in the inner Rind of the Root, this coats it over; and having, from its extravaſated Juices renewed its own coat, or formed what has been called the ſecondary outer Bark of the Hellebore, the Bud riſes ſo far perfect.

At ſome height above the ground the vigorous Flower breaks thro' the Shell *d* alſo, which being thus ſplit, ſpreads off ſideways, and conſtitutes the internal ſubſtance of thoſe two Films, *l m*, which in this young ſtate cover the Flower. The outer and the inner Rind having riſen with the Blea, ſpread themſelves alſo over theſe Films, and cover them entirely. In the uppermoſt of theſe, *m*, the new outer Bark entirely terminates; but the inner Rind, *n n*, ſtill purſues its courſe up the Stalk, even to its ſummit, where ſpreading into Breadth it forms the two under or outer Petals of the Flower, *o o*, and there terminates entirely.

This courſe of the two Rinds is peculiar to the Hellebore, and ſome few other Plants of the like kind: for in the generality of Herbs the outer and the inner Barks riſe together with the Blea, in a plain continued and uninterrupted courſe, from the Root into the Stalk. As the young Bud of this Plant muſt pierce the earth in the ſevereſt Froſts, Nature has by this peculiarity of ſtructure in the Crown covering it, provided for its defence.

CHAP. XVII.

Of the Construction of the Inner Rind.

THE outer Bark having been removed from ſeveral pieces of the Hellebore, all theſe are now ready for the taking off the inner, which we are about to examine; and if they have been left in the water till now, they will be in a condition to part with it the more eaſily. It is nearly in-

different from what part of the Plant we take a piece of this Rind for examination, for there is not variation in the diſpoſition of the Veſſels in the body of the Root and other parts, which we ſee in the outer Bark: it will be beſt therefore to take the piece for examination from the Flowering Stalk juſt above the ground, that being the part eaſieſt compared with others.

A SMALL piece of the inner Bark of the Hellebore thus ſeparated, and cleared perfectly in water with a camel's hair pencil, appears compoſed of many couches, beds, or flakes of an uniform matter, laid evenly upon one another. This is the firſt and moſt obvious diſtinction between the inner Rind and the outer Bark; the laſt being one ſimple flake, compoſed only of two Membranes with a reticulation of Veſſels between them. Theſe numerous couches give the thickneſs of the inner Rind; for each couch or bed is not thicker in this than in the outer Rind.

THE firſt care muſt be to ſeparate one ſingle couch of theſe from the reſt: they are all alike in ſtructure, but when they lie one over another, the object is confuſed. A ſmall piece of a ſingle couch of this Rind appears before the Double Microſcope perfectly tranſparent, and almoſt colourleſs. The Veſſels ſtand at conſiderable diſtances, aſcending in waved lines, and inoſculating often one with another. There are a great number of bars joining theſe Veſſels one to another; and theſe are not arched or tranſverſe, as in the outer Bark, but always oblique: ſuch a piece, as it appears to the Double Microſcope with a very conſiderable power, is repreſented Plate IV. Fig. 43.

BY working upon a ſmall piece in water with fine camel's hair pencils, we can ſeparate the Membranes from the Veſſels in this as in the other Bark; and a larger power of magnifying being applied, a piece thus prepared, ſhews that each couch or plate of this Rind conſiſts of two Membranes, with a ſeries of Veſſels between them; as the compleat outer Bar: but theſe large powers of magnifying ſhew us alſo ſomething more, for between thoſe Veſſels there is a ſpungy ſubſtance, filling up every where the ſpaces; tho' unleſs by a very careful eye, ſcarce to be diſtinguiſhed from the Membranes themſelves. A piece thus magnified, is figured at 44: and the three diſtinct parts of which it is compoſed, at the three following numbers; 45 repreſents a piece of one of the Veſſels ſeparated, and yet more powerfully magnified; 46, the Membrane; and 47, a fragment of the ſpungy ſubſtance.

WITH this great power of magnifying we ſee the conſtruction of the Veſſels very plainly. Each is a ſimple hollow tube, ſtudded on all ſides,

as

as it were, at ſmall diſtances, with a kind of oval Glands, 45, b. In theſe there is no ſimple aperture, as there is in the ſwellings of the Veſſels of the outer Bark; but they ſeemed pierced all over with very minute holes, from which there iſſues a whitiſh fluid, thicker than the Juice of the outer Bark.

Beside theſe prominent parts, whoſe purpoſe plainly is to diſcharge an abundant moiſture, there are others of the ſame form, and equally numerous, which are of a duſkier colour, and are a little hollowed inward. The office of theſe ſeems to be to receive.

There are diſtinctly ſhewn in the large Veſſels, at the Figures 48 and 49; the firſt of which repreſents a piece of a ſingle couch of this Rind, with its two Membranes ſeparated, as it appears before a very great power to the Double Microſcope; and the latter, the Veſſels of the ſame part taken out from between thoſe Membranes.

After this examination of a ſingle Couch of the inner Rind, it will be proper to examine the ſeveral together which make up its whole thickneſs. We find by this view, that the Veſſels in all theſe Couches are united to one another, by thoſe ſhort obliquely diſpoſed Veſſels, which we call the Bars of Union; but that there are none ſuch between the Veſſels of this Rind and of the two diſtinct ſubſtances placed next to it. The communication between the outer Rind and this, is only by the mouths of the Veſſels of the outer Bark, which open into the interſtice between the two, and thoſe of the inner Rind, juſt deſcribed as depreſſed, not riſing above the ſurface. This is the more certain, becauſe there are only the depreſſed mouths on the outſide of thoſe Veſſels of the inner Rind, which form the outer Couch, and come next to the outer Bark. This is expreſſed in the Figure 48, which is the outer ſurface of a piece of the outermoſt Couch of this inner Rind; and in 49, which exhibits the ſame ſurface of two of the Veſſels taken from between thoſe Membranes. It appears by theſe examinations, that the croſs-bars which join the aſcending Veſſels one to another, are alſo tubular, for they have the ſame mouths upon them.

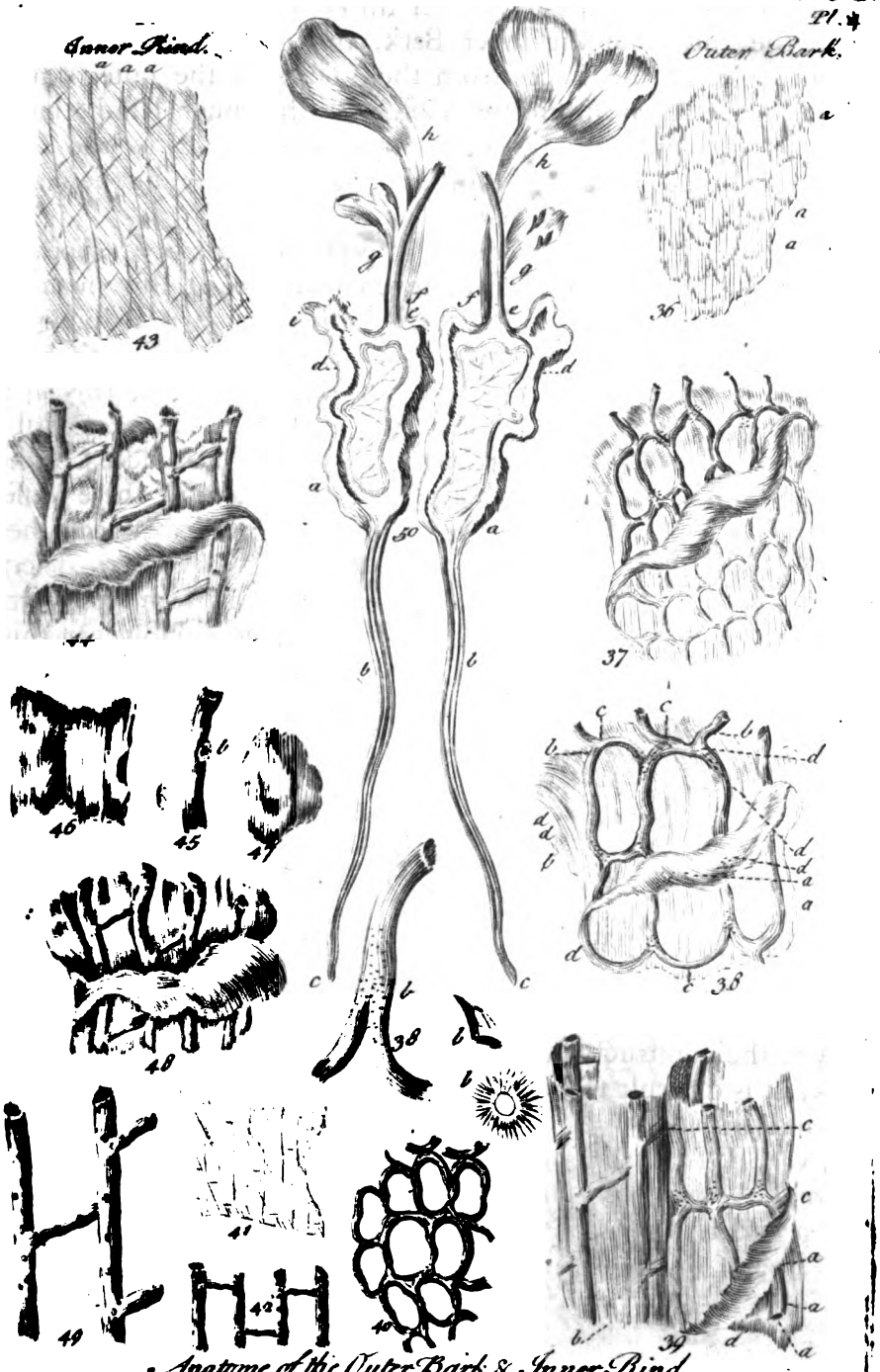
By theſe gradual advances we make ſome progreſs toward a knowledge of the Vegetable Structure: we ſee the communication between the ſeveral Couches, which together compoſe one ſubſtance, is of one kind, and that between one ſubſtance of the Plant and another, is of a diſtinct ſort. Thus the Veſſels of the ſeveral Couches which form the inner Rind, are united ſimply by tubular bars, in the ſame manner with the ſeparate Veſſels of the ſame Couch; the original Juice received into the part paſſing with

equal freedom from one Veſſel to another throughout the whole ſubſtance: but between the outer and the inner Bark, the communication is altogether different: part of the Juices from the Veſſels of the outer Bark appear, indeed, to be received into the Veſſels of the inner Rind; but it is after extravaſation; and after an alteration plainly made in the Glands, which diſcharge them; probably alſo, after another made in the glandular mouths, by which they are received.

ANOTHER part of Nature's operation in perfecting the Sap, appears alſo very evidently and very ſingularly in the conſtruction of this inner Rind. Beſide the Membranes which incloſe theſe Veſſels, there is a ſpungy ſubſtance between them: the ſame Veſſels alſo have Glands for diſcharging, and mouths probably glandular alſo, for receiving fluids; and this in parts where no Juice can be received by the one, but what has been firſt diſcharged by the other. This is evidently the caſe of the middle Couches of this Rind. It ſeems, therefore, that part of the Juices of theſe Veſſels is diſcharged thro' the prominent Glands, into the interſtice between the two Membranes, and there received by the ſpungy ſubſtance before deſcribed, in which it ſuffers ſome change, and is then received by the hollowed or depreſſed mouths of the ſame Veſſels into them again. However this be, the conſtruction of the parts is evident, and we ſee what is the connection of the outer and inner Rinds of Plants.

PURSUING this ſubject as the former, thro' other inſtances, we find that in the Polyanthus the inner Rind is conſtructed exactly as in Hellebore, only the Veſſels are more diſtant, and in ſome places divide into two, in their aſcent. In the inner Rind of the Anemone, the Veſſels are placed yet more diſtant, and run quite ſtrait. In both theſe the two kinds of glandular mouths, the prominent and the depreſſed, are placed as in the Hellebore; only in the Polyanthus they are very minute, and thick ſet; but in the Anemone, on the contrary, they are much larger, and more diſtant. In the Hyacinth the oblique bars are larger and more numerous, but otherwiſe the conſtruction is entirely the ſame; the Juices of this Plant being thick, it is difficult to get the parts perfectly clear of one another; but the Glands are ſeen to more advantage.

IN the Narciſſus the Croſs-bars run leſs obliquely; the aſcending Veſſels ſwell between joint and joint, and the Glands of both kinds are numerous, but minute, and are ſituated only on the ſwelled part. We ſee by theſe examples, that altho' the diſpoſition of the Veſſels of this Rind varies a little, their conſtruction is the ſame; and we thus know what is the ſtructure of this ſecond of the conſtituent parts of every Plant. All



Anatome of the Outer Bark & Inner Rind.

that we can wiſh more, is to ſee the ſtructure of the inner ſurface of the innermoſt coat of this Rind in Plants, becauſe that comes next the Blea; and Reaſon ſays it ſhould have the ſame connection with it that there is between the outer and the inner Rind.

THIS Coat may be obtained ſeparate; but it requires great care, and a nice hand to get it. We find it compoſed, as the others, of a ſeries of Veſſels between two Membranes; but the Veſſels are larger than in the reſt; and the ſpungy matter here is very little. On the outer ſurface of theſe Veſſels there are only receiving, that is only the depreſſed mouths; and on the ſurface next the Blea, there are only the prominent oval Glands, which ſeem made for the diſcharge of the abundant fluid. It ſeems, therefore, that while the waſte part of the Juices of this inner Rind gently aſcend to the top of the Plant, there is a part of them elaborated by various changes, and at laſt delivered to the Veſſels of the innermoſt Couch, which give it to the Blea.

CHAP. XVIII.

Of the COURSE of the BLEA.

THE Blea of Plants, which is the third ſubſtance in our tranſverſe ſections, is ſeen great in quantity, and ſeems compoſed of very large Veſſels: this appearance however is deceiving. What ſeem Veſſels, are but the interſtices between Veſſels; the vaſcular part being very minute in this, and all the vegetable frame.

IF we trace the Blea, as we have done the outer Coats, we ſhall ſee it covering the entire Plant, immediately under the inner Rind: and its origin being placed in the body of the Root, we find it deſcending the length of the Fibres, and rounding all their ends, aſcending to the body of the Root again, and thence running up the Flowering Stalk, and Leaf Stalks, loſing itſelf in the Leaf Stalks, at that part where the extreme Fibres of the Leaves themſelves end; and terminating abſolutely in the Flowering Stalks in the three inner Petals of the Flower. This courſe of the Blea is repreſented in Plate IV. Fig. 50. in a Plant of Hellebore made up of ſeveral pieces, diveſted of the two Rinds, and with the Blea, which is there its outer covering, laid back from the parts within.

FROM

FROM the body of the Root, *a c*, which was its original part in the Seed, and in the Seedling Plant, its courſe downwards into the Fibres, *b b*, is plain, and it rounds them at *c c*: aſcending thence to the Crown of the Root, at *d d*, it enters the Leaf Stalks, *e e*, by a plain and ſimple continuation in growth upwards; but its aſcent up the Stalk for flowering, is a matter of more delicacy: we ſee it in this full-grown ſtate of the Plant, aſcending ſimply up the Stalk, in a continued courſe from the Root, at *f f*, juſt as in the Leaf Stalks: at *g g* it forms a fleſhy lining of the two Films, which is here repreſented as it appears when ſtripped of the inner Bark; and finally at *h h* it comes to an abſolute termination in the Petals.

AT *i*, the Flower, with its rudiment of a Stalk, is repreſented in the Bud; but to ſee this more diſtinctly we muſt refer to the preceding Plate III. where, at the Letters *i i*, *c c*, *d d*, the conſtruction of the Bud, and courſe of this part are repreſented more at large; becauſe with all their parts. The Bud *p*, lodged within the ſhell *b*, is encompaſſed there by the Rinds and Blea. The Rinds fall off as the Bud riſes, as at *c c*; and finally the inner Shell *d*, now expoſed to the air, burſts alſo from the riſing of the Bud, in the ſame manner. It might then ſeem that the Bud, *p*, ſhould riſe naked thro' it: but Nature has contrived otherwiſe. The whole inner Rind riſes in the Shell, *c c*, but the inner Shell, *d*, is not formed of the whole Blea, but is a duplicature only, riſing from the part *g*; where the baſe of the Bud is formed upon the Fleſh of the Root. Therefore the rudiment of the Stalk, which lies here, is covered with its proper Blea; from the ſurface of which only riſes that portion of it which forms the Shell: and for this Reaſon, when the Shell burſts as the Stalk riſes, its divided parts, *c c*, riſing with the Stalk as far as *l m*, there form the inner body of the two Films; but the Stalk riſes cloathed with its Blea, from *q* to them, and above them, till it terminates at the three inner Petals. Theſe Petals, which being carefully folded over one another, form the head of the Bud, *p*, have therefore the extremity of the Blea upon them, when they pierce the Shell, *d*, formed of a duplicature of it, and afterwards forming the bodies of the Films.

CHAP.

CHAP. XIX.

Of the CONSTRUCTION of the BLEA.

HITHERTO we have ſeen the Coats, or conſtituent ſubſtances of a Plant, ſimply ſurrounding, or plainly and uninterruptedly covering one the other; but in the Blea it is much otherwiſe. This makes a coat much thicker than the reſt; but the next ſubſtance under this runs into it in various proceſſes. I cannot wonder this has not been obſerved, for few have had the attention to conſider Plants in the various effects of maceration; and it is only in certain ſtates, tending toward decay, that this wonderful conſtruction can be ſeen. This being firſt underſtood, we ſhall be in a condition to examine the conſtruction of the Blea; by being aware of a different part thus mixed among it. As it is the Fleſh of the Plant which thus runs in among the Blea, the different colour of its Juices will diſtinguiſh it to the cautioned eye. The Juices of the Blea in Hellebore are mucilaginous and whitiſh; thoſe of the Fleſh are green and coarſe. They are to be ſeen in the Veſſels making the corners of the hexagon Cells; which Cells are alſo larger.

THUS prepared, we are to examine the Blea; and as it is a part of conſiderable thickneſs, it will be beſt firſt to conſider it in the tranſverſe ſections, as in that enlarged part of the Root, Plate III. Fig. 28; and of the Flowering Stalk, Fig. 30 of the ſame Plate. We find in the thickneſs of the Blea in theſe various parts, from ſix or eight, to fourteen or more beds of hexagonal Cells; and it will be proper firſt to enquire what theſe are. They are Membranes, whitiſh, and very thin; but at the angles they have a thicker aſpect, and on examining more ſtrictly, we find this thickneſs ariſes from a Veſſel in each of thoſe Places. Theſe Veſſels are conſiderably larger than in either of the Rinds; and we plainly enough diſcern their cavities, when it is a new-cut piece that we examine. Theſe Veſſels form the ſolid part of the Blea, and they are connected and kept in their places by Membranes. They riſe in diſtinct arrangements, ſix in each; and theſe make the ſix angles of the ſeveral hexagonal Cells. Therefore the Blea is not compoſed of various Couches of Veſſels between two Membranes, as the inner Rind; but is one compleat and ſingle ſubſtance, uniform in its ſtructure; and the whole of it is contained between two Membranes, which are thin and pellucid. The Juice, which is abundant in theſe Veſſels, continually

continually diſcharges its watery part into the Cells between them; and perhaps there are other ſources of a ſimple fluid which fill them. Certainly the great quantity of water imbibed and perſpired by Plants, is principally lodged in theſe Cells of the Blea.

HAVING thus far examined the general ſtructure of the Blea, we are to proceed in our ſearch, by taking off a thin piece from its outermoſt part lengthwiſe. Such thin pieces are eaſily obtained from the thickneſs of the inner Rind, becauſe it is compoſed of ſeparate Plates or Couches; but in this we muſt obtain by art what offers itſelf ſo eaſily there. To this end, having ſeparated the two Rinds clean from a piece of the Flowering Stalk of Hellebore, we are to raiſe a thin piece of the Blea with the point of the Lancet-ſciſſars; and taking hold of it with fine Plyers, to tear it off, lengthwiſe, and upward, from the reſt. The thinneſt part of this is to be worked well on its inner ſurface in water, with a camel's hair pencil; and with due care we may waſh away all but one ſeries of Veſſels and their Membranes. The inner ſurface will be irregular, but the thickneſs will be no more than that of one Couch of the Rind.

WE thus ſee the Courſe of the Veſſels, riſing in a curved manner, and connected together by very frequent arched ones, placed, as the croſs-bars, in the two Rinds; but with this great difference, that here what appear as arched parts in this view, when we ſee the whole more enlarged, are found to be really portions of the Veſſels themſelves, not ſeparate Veſſels ariſing from them, as in the Rinds.

A PIECE of the outer ſurface of the Blea, with the exterior ſide uppermoſt, appears to the Microſcope with a conſiderable power of magnifying, as at Fig. 51, Plate V. What ſtrikes the eye firſt in this view is, that there appear a kind of interſtices at the places where the Veſſels paſs over one another: but this is the natural reſult of their form. Theſe Veſſels do not run up ſtrait, as thoſe of the Rind, but bend backward and forward, repeating from ſpace to ſpace, the form of the letter S. Any two of them which run in this form, in an oppoſite direction, will croſs one another at the two places where the bend is made, and conſequently there will be formed between them two elliptical figures, or one ſuch figure by each half of the double S. This cannot be ſeen diſtinctly in a piece of the ſubſtance managed as at Fig. 51, becauſe the Veſſels will have been forced a little from their original courſe, by the violence uſed in preparing the piece; but even in that fragment which is engraved exactly from Nature, ſomething of this general courſe may be ſeen, and the whole will be underſtood diſtinctly

tinctly by the parts of two Veſſels taken out from the Blea, and laid in their natural form, as at Fig. 55.

THE ends of theſe two Veſſels, *a*, *b*, *c*, *d*, proceed in their natural courſe to form two other ſuch elliptical ſpaces, as *d*, and being on each ſide touched by others of the ſame kind, and running in the ſame manner at *e e*, there muſt neceſſarily be little ſpaces at the angles *f*, *g*, *h*, *i*, the ſame with thoſe at *a a a a*, in Figures 51, 52, 53, 54.

THESE Veſſels of the Blea, where they paſs one another, as at *k k*, Fig. 55, do not ſimply go over each other, but abſolutely inoſculate, or open into one another; and the ſame thing happens at their ſides, *c c*, Fig. 55, and *b b*, Fig. 52, where running cloſe to one another, they unite and become one Veſſel.

THIS is the vaſcular conſtruction of the Blea, and it is in the higheſt degree ſingular; for by this means its whole ſubſtance is, in a manner, one maſs. The Juices paſſing along many Veſſels, as if they were but one; and the diſpoſition of theſe at the ſame regular diſtances, Fig. 55, *c c*, throughout the whole ſubſtance of the Blea, makes them form a ſyſtem of regular tubes, lined with their own Membranes; which appear as ſo many large Veſſels, and have, in ſome degree, the effect and office of ſuch in the Plant.

To know the conſtruction of the outer ſurface of the body of the Blea, or that which lies cloſe to the inner Rind, it will be proper to apply larger magnifiers, and to work the fragment 51, with a pencil in water, till we in ſome degree get it to pieces. Fig. 52 repreſents a view of ſuch a piece, in which I ſucceeded ſo far as to ſeparate and puſh back the outer Membrane; and by that means obtained a better view of the Veſſels. The Membrane, *c*, is thick, but colourleſs; and it forms a very perfect and entire coat to the Blea. This is continued alſo inward, in ſeveral portions, always double, and ſurrounding all the Veſſels; and it is this which makes the Cells between the ſeveral arrangements of Veſſels; which Cells have themſelves been generally conſidered as the Veſſels of the Plant.

THIS inward ſtructure of the compleat body of the Blea is very ſingular. Every ſeries of Veſſels is wrapt up in a double Membrane; and the places where they are moſt plainly diſtinguiſhed, is where they join.

WE have ſeen how the inward Rind is connected with the Blea; we are to ſee in what manner the Blea is united to, or how it communicates with the ſubſtance next within it; this is the Vaſcular Series. It is eaſily diſtinguiſhed by its greener colour, and by the ſmallneſs of the Veſſels.

NATURE in this obſerves a gradation, as if the change from the wide cells formed by the arrangement of the Veſſels of the Blea, to the ſingle courſe of theſe ſmall ones, were too great and violent: as the Blea runs more inward, that is, as it approaches this Vaſcular Series, they become ſmaller, the Veſſels alſo which compoſe them, become themſelves leſs, till the two or three innermoſt parcels are mere threads. Cloſe within theſe lies the Vaſcular Series, of which we are to ſpeak in the next chapter; and the inner range of the cells of the Blea ſticks cloſely to it.

To underſtand this union, they muſt be torn aſunder gently, and only in part. To this purpoſe cut a tranſverſe ſection of the Stalk near the ground, and then cut out of this a ſmall piece from the ſurface to the Pith: faſten the piece upon a flat cork, with a fine needle in a handle, and with one of the crooked needles take hold upon the Rinds, draw them away, and they will come off together. In the ſame manner lay good hold upon the Blea, and gently draw it away. The connection between the Blea and the Vaſcular Series, is ſtronger than between the ſeveral parts of the Blea itſelf: therefore the ſubſtance of the Blea will be very apt to break inſtead of ſeparating from this matter within it; but by care it may be got fairly aſunder.

A PIECE of the two ſubſtances which I was ſo happy to ſeparate in this manner, is repreſented at Plate V. Fig. 53. Where the ſeparation being abſolute between the anterior part of the two ſubſtances, while they yet remain fixed together behind, we ſee the nature of their connection. In this Figure *a* repreſents the Blea; and *b* the Vaſcular Series, of whoſe compoſition we ſhall ſpeak preſently.

FROM thoſe parts of the Veſſels of the Blea where they croſs one another, there riſe ſmall oval Veſicles; the broad ends of theſe riſe from the Veſſels of the Blea, and the ſmaller ends always fixed to ſome part of one of the Veſſels of this Vaſcular Series. They pierce the Membranes on each part, and hold the two ſubſtances together, at the ſame time that they make a communication between them.

A PIECE of the inner ſurface of the Blea is repreſented at Fig. 54, vaſtly magnified, to ſhew the origin and place of theſe Veſſels; and one of the Veſſels itſelf at 56. This kind of union is kept up between the innermoſt coat of the Blea and the Vaſcular Series throughout the whole Plant.

CHAP.

CHAP. XX.

Of the VASCULAR SERIES.

THE fourth ſubſtance of the Plant, whoſe thinneſs had occaſioned its being hitherto overlooked, is the Vaſcular Series. This, in the Hellebore and moſt other ſpecies, is a ſingle courſe of Veſſels, lodged between two Membranes; a ſlight view of which we have given at Fig. 53, Letter *b*; and a more diſtinct one at 57, and the ſucceding Figures.

WHATEVER part of the Plant we examine, excepting the Footſtalks of the Leaves, we find this ſubſtance. It lies cloſe upon the Fleſh every where, and ſeems preſſed between that and the Blea. Its courſe in the entire Plant is repreſented at Fig. 57. We are to conſider the object of this Figure as the ſame Plant of Hellebore with which we began: that is, a ſingle Root torne from the entire Cluſter, repreſented Plate I. with an aſcending flowering Stalk and one Fibre. This we repreſented ſplit in Plate II. Fig. 24, with the outer Bark thrown off: in Plate III. the inner Rind is ſeparated in the ſame manner; and has taken with it the two outer Petals: in Plate IV. Fig. 50. the ſame Plant is ſtripped of its Blea, which takes with it the three inner Petals; ſo that in the preſent Figure 57, the Plant is reduced to the covering of the Vaſcular Series, which is here repreſented as laid back from the Fleſh; and the aſcending Stalk cut off within it, to prevent confuſion.

THUS we can trace the courſe of this ſingular part of the Vegetable Structure entire. If we follow it from *a*, in the body of the Root, downwards, we find it coating the Fleſh of the Fibres at *b b*, returning round their ends at *c c*; and having aſcended over the whole body of the Root, proceeding upwards in a continued ſubſtance to coat the Fleſh of the Stalk at *d d*; and finally terminating in the Flower; there forming thoſe wonderful bodies the Nectaria. This is its place, and this its courſe in the entire Plant. Its office is to feed thoſe tubular bodies in which it terminates; we ſee nothing of it in the Footſtalks of the Leaves, becauſe no ſuch bodies are to be found, except in the Flower.

CHAP. XXI.

The CONSTRUCTION of the VASCULAR SERIES.

WE have examined complex objects hitherto: this is extremely ſimple. When we view it in a tranſverſe ſection of any part of the Plant, it ſcarce appears unleſs to the great magnifiers; and then as a dotted line only, ſurrounding the Fleſh, and ſeparating it from the Blea. See Plate III. Fig. 25, *a*. But the other coats of the Plant being taken off by maceration, it is eaſy to raiſe and looſen ſmall pieces of this. A bit thus ſeparated, waſhed clean, and laid in water before the Microſcope, appears to the common magnifying powers only as a yellowiſh ſkin, with ſeveral green cords running up it. See Plate V. Fig. 58. To ſhew its ſtructure better, we muſt uſe greater powers; and treat this as the other parts, by bruſhing it in Water, to get the coats aſunder.

A PIECE of this Vaſcular Series taken from the Flowering Stalk of Hellebore, near the ground, and examined with this attention, ſhews perfectly the ſtructure of the part. The Veſſels are found to be lodged between two yellowiſh Membranes; and we ſee in many places thoſe little oval Veſſels which unite the ſubſtance and the Blea with it; and elſewhere the marks of them, and the perforations of the Membrane thro' which they had paſſed. A piece thus magnified, appears to the great magnifiers, as Fig. 59, where *a* repreſents the outer Membrane, *b* the inner Membrane, and *c* the Veſſels themſelves between.

THESE Veſſels are very differently diſpoſed from thoſe of the reſt of the Plant; they are large, tolerably ſtraight in their courſe, and, ſo far as I have yet ſeen, have no communication whatſoever one with the other.

THEY are ſo ſtrong that they are more eaſily ſeparated from their Membranes than any others; and I have ſometimes been ſo happy to remove them clean from them, as at Fig. 60, with the Veſicles of communication yet adhering to them. One of thoſe Veſicles is repreſented ſeparate at 61, with the manner of its joining the Veſſels of this Series.

WE have obſerved, that theſe Veſſels terminate in the Nectaria of the Flower; and it is not impoſſible to trace them thither; though in their courſe through the Receptacle of the Flower, which is that fleſhy head from which theſe and the Filaments riſe, they are much leſs diſtinct than elſewhere. The firſt particularity that occurs, is, that theſe Nectaria are

only twelve; whereas the Veſſels of this Series are at leaſt ten times that number: the ſimple courſe would have been, that one Veſſel ſhould have terminated in one of the Nectaria; but the Flower would then have been encumbered with Nectaria, and Nature would have omitted the final change in their Juices made in the Receptacle, in that part where they ſeem to loſe themſelves.

THE Veſſels, Fig. 59, having aſcended with their Membranes about them, as far as the part *ff*, in Fig. 57, there form a wonderful plexus one with another in the body of the Receptacle. This Receptacle has its place juſt where the Petals begin to expand, and it is formed principally of that white ſubſtance which ſurrounds the Conic Cluſters; of which we are to ſpeak in a ſucceeding chapter. From this fleſhy lump riſe the Filaments as well as the Nectaria, and even the inner Petals are connected with it at their baſe; its ſhape is oval, and the broad part is downwards. When we cut it thro' longitudinally we ſee its Coat thick, and when tranſverſely, the appearance is much the ſame. The white ſubſtance ſurrounding the Conic Cluſters is ſpungy; and here, where it ſwells into a kind of head, its texture becomes more compact. Two views of it in the longitudinal and tranſverſe ſections, are repreſented at Fig. 62, 63. To examine it more regularly, the proper method is to cut off a thin piece, together with one of the Filaments, and one of the Nectaria. Purſuing the ſtroke carefully downward, we ſhall not fail to bring away a part of the Vaſcular Series: this we are to waſh carefully with a fine pencil, and we ſhall then have the abſolute continuation of theſe Veſſels into the Nectaria before us.

SUCH a piece is repreſented at Fig. 64, with the Nectarium and Filament enlarged. All we ſee in this power of magnifying is, that between the baſe of the Nectarium, *a*, and the top of the Veſſels *b*, there is a ſubſtance unlike to either of them, in which the Veſſels ſeem to terminate, and from which the Nectarium ſeems to riſe, as alſo the Filament. There requires more power of magnifying to ſee what courſe they take diſtinctly. With a larger power we diſtinguiſh, that the Veſſels enter this white maſs, diminiſhing as they proceed, and gradually loſing their colour; but we loſe them, even in this view, in their progreſs. See Fig. 65, *a b*. A ſmall piece of the white maſs, 65, *e*, muſt be pared of with a fine knife extremely thin, and in the exact courſe of the Veſſels; and this being laid in water before the moſt extreme power of the Double Microſcope, we then ſee the Veſſels gradually diminiſhing, and becoming paler as they run into this

this ſubſtance; and toward the ſurface where the Nectaria are to riſe again, enlarging, and many of them uniting into one, giving riſe to the Nectaria.

A VIEW of this is given at Fig. 66, in which we ſee the green Veſſels loſing their colour as they enter the body at *a*, and acquiring it again when they become expoſed to the air, in their united form at *b*, riſing in the new form of the Nectarium. A tranſverſe ſection of a piece of the Receptacle, is repreſented at Fig. 67, in which the Veſſels are ſeen uniting as they approach the ſurface.

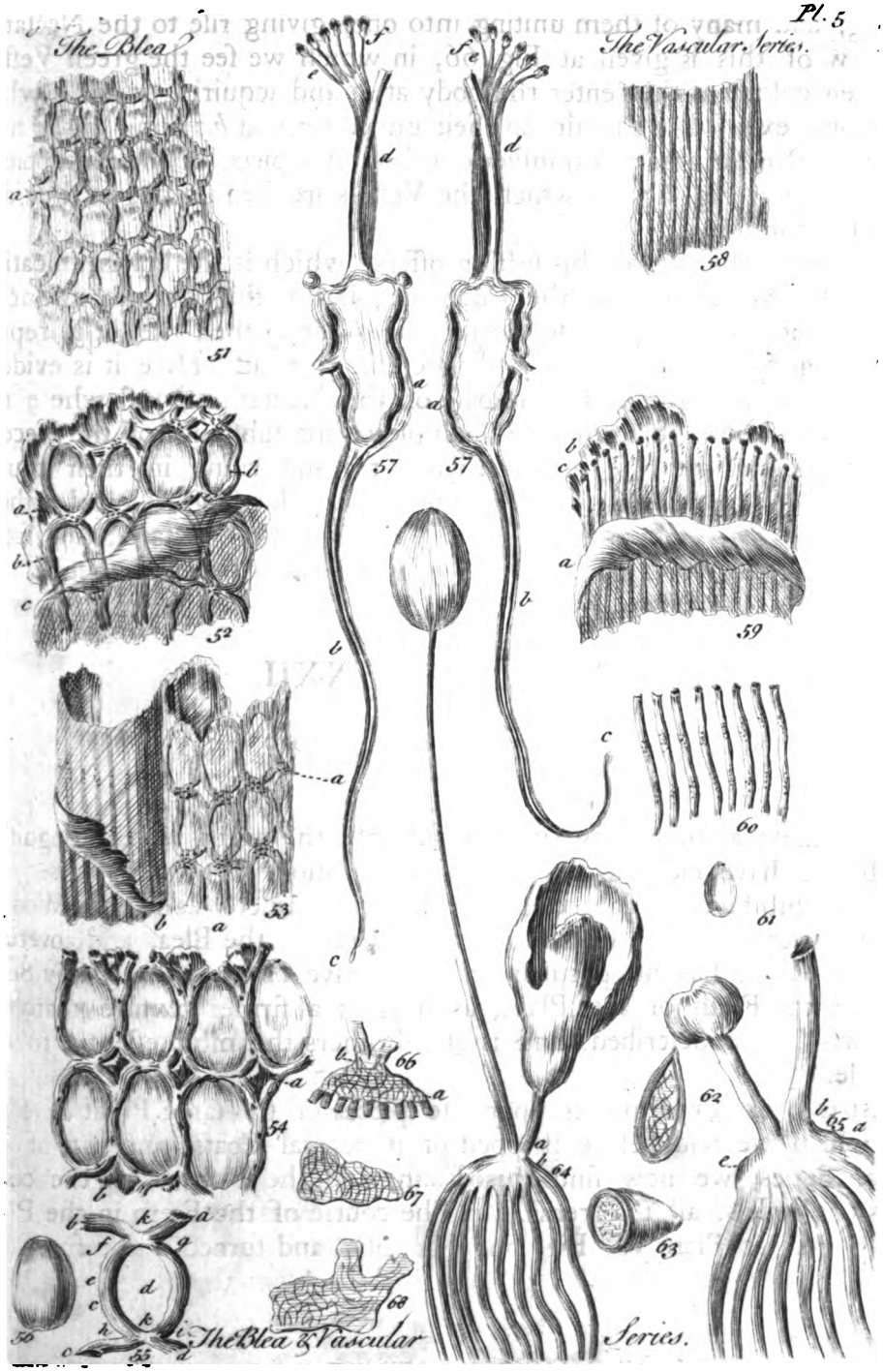
ONE further obſervation this ſection offers, which is the communication between the Nectarium and the Filament; but as this is more diſtinctly ſeen when the ſection is made nearer the place of their riſe, it is repreſented at Fig. 68, as it appears juſt under the ſurface. Here it is evident that ſeveral Veſſels ariſe from the baſe of the Nectarium, juſt where the Vaſcular Series unites to form it, which pierce the ſubſtance of the Receptacle, juſt below the baſe of the Filament; and riſing in their courſe plainly run up into its hollow. Thus terminates this ſingular, and hitherto unobſerved part, the Vaſcular Series; forming the Nectaria, and from thence plainly delivering Juices to the tubular body of the Filament.

CHAP. XXII.

Of the FLESH of the PLANT.

THE name alone is new in this ſubject; the part is too diſtinguiſhable to have eſcaped the notice of the moſt ſlight obſervers. In Trees, the ſubſtance which covers the Pith is diſtinctly called the Wood: in Plants, there is ſuch a ſubſtance alſo, covered by the Blea, and covering the Pith, but it has no peculiar name; I have called it the Fleſhy Subſtance, or the Fleſh of the Plant, as it is of a firmer texture than the ſlight parts before deſcribed, and is of all others the moſt eſſential to the Vegetable.

PURSUING our experiments upon the pieces of the ſame Plant of Hellebore which we had before ſtripped of its ſeveral Coats, and laſt of the Vaſcular Series, we now find this Fleſh, and the Pith, with the conic cluſters of Veſſels, all that remain. The courſe of the Fleſh in the Plant is repreſented at Plate VI. Fig. 69, 69, ſplit, and turned back from the Pith. Tracing this as the others, we ſhall find ſomething peculiar in its diſ-



diſpoſition; and ſhall, without much difficulty, diſtinguiſh that it has been the original portion in the ſyſtem, producing not only its ſeveral Coats, but all the parts.

In the body of the Root we ſee this is a maſſy ſubſtance, forming the entire circumference of that body, and ſending upwards portions from its outer ſurface, to form the Fleſh of the Stalk, and downwards for the Fibres. This has been explained at large in the Anatomy of the Root, in Plates II. and III. We ſee it very diſtinctly in a Plant thus managed, and cannot but obſerve a vaſt difference between the courſe of this part and the others: the Coats of the Stalks and Fibres are plain continuations of the Coats of the body of the Root; but the Fleſh of the Stalks and Fibres are not continuations of the Fleſh of that body, but only productions of it. This Fleſh thus becomes a part alſo of the entire Plant, rounding the ends of the Fibres and their heads, in the ſame manner rounding the body of the Root, and in a proceſs thence running up the Stalk, where it does not return upon itſelf, but when it has reached the Flower, divides, and forms the Filaments, 69, *a a*, tho' not without the intermediation of the Receptacle.

There the ſeveral Veſſels of the Fleſh of the Plant loſe themſelves in the ſpungy ſubſtance formed by the Coat of the Conic Cluſters, and riſing again from its upper ſurface, diverge into the Filaments.

CHAP. XXIII.

Of the Construction of the Flesh, or Fleshy Substance.

We enter now upon the moſt important examination in the Vegetable Anatomy: This is a part the moſt eſſential to the Plant of all; indeed, the only part which is eſſential; yet it has been hitherto the leaſt underſtood.

The other parts of the Vegetable Structure, are one or other of them wanting in various Plants, or various Parts of Plants; and we ſee the ſyſtem can exiſt, and enjoy its ſpecies of life without them: they, therefore, are not eſſential. But no Plant, nor any neceſſary part of a Plant, is ever found without this ſubſtance: therefore it is eſſential, and alone eſſential to the Vegetable Life.

It

It is, indeed, the only part wherein is immediate Growth, and is itſelf capable of producing all the others. It will live alone: but all the others cannot live without it. It will produce them all: but none of them can produce it. If the Pith be ſcooped away in one Plant, and the Coats taken off in certain parts of others, this Fleſhy Subſtance will ſhoot a new Pith inward, in the one caſe, and new Coats, even all of them, in the other: but if ever ſo ſmall a portion of this be taken away, it never is reſtored.

It is univerſal in the Plant, whereas others terminate in particular places; and it produces all the reſt. The Filaments in the Flower, which are the eſſential part in the production of new Plants, are continuations of it: and as the Seed Veſſels are portions of the Pith which it ſhoots inward, ſo are the Petals and Nectaria of the Rind, Blea, and the Vaſcular Series, which this part ſends outward.

It covers the Pith every where, and returns upon itſelf in ſeveral places: for tho' it is found in every part of the Plant, it is not entire every where. The Root, we ſee, has a regular caſe of it, independant of the Stalk: and it is a part of the ſurface of this caſe only which riſes occaſionally, as the ſeaſons call it, into the Stalks. Theſe have a connected portion of it during their vigour; but in the Body and Fibres of the Root it exiſts perfect and independent of them: therefore the Root has Vegetative Life when no Stalk riſes from it; poſſeſſing alſo the Flavour and the Virtues.

Such is the importance of this part, that it properly conſtitutes the character of the Vegetable Syſtem, diſtinguiſhing that great arrangement of Beings from the two other kingdoms. Nature has impreſſed indelible and invariable marks of this diſtinction, if men would have obſerved them. The characteriſtic of an Animal Body, we have ſhewn, is the having a ſyſtem of Nerves; the character of a Vegetable Body is, the having this Fleſhy Subſtance: Senſation ariſes from the Nerves of Animals; and growth from this part in Plants. Such is its importance; let us trace now its ſtructure.

It is the original Plantule in the Seed; it ſwells into the body of a Root when that Seed is ſown, ſhooting a Blea and two Rinds outwards, and a Pith inwards. Thence it is continued in a new growth downward into Fibres, rounding their ends as an arch, and upwards into a Stalk. But in the body of the Root it is entire: the Pith there is ſurrounded by a plain and regular Coat of it; and tho' the Stalks and Fibres riſe from it, yet its whole ſubſtance is not continued into them.

Wherever

WHEREVER a Fibre is to be produced, a portion of the ſurface of this Fleſhy Subſtance riſes in a Bliſter, and forcing its way outward, takes the Coats with it. The courſe of the Fleſhy Subſtance itſelf is not altered by this; only a portion is raiſed from it. Thus it is entire in itſelf; and thus all the parts of a Plant are produced by it.

IT is extremely difficult to know its ſtructure, for the great quantity of matter in it renders it opake. Sections cut tranſverſely from a Fibre, ſhew it beſt; but when the other parts are cleared away, the Vaſcular Series, and Conic Cluſters, remain fixed firmly to it; itſelf appearing of a woody ſubſtance. See Plate VI. Fig. 70, where *a* is the Fleſhy Subſtance, *b* the Vaſcular Series, which ſurrounds it, and *c* the Conic Cluſters within. But in this view we diſcover very little of its own texture.

IN ſections cut from Fibres longer macerated, we ſee that it is vaſcular, as at Fig. 71; but it is not compoſed wholly of Veſſels, for there are Ribs of a ſolid Matter in the angles, which are form'd between them. We muſt go further yet to ſee it truly. A ſection of a macerated Fibre muſt be cleaned in fair water, hardened in alum-water, and then plunged in ſpirit of wine; in this it is to remain a week, and we ſhall then have it in a condition fit to be viewed.

THE Veſſels of which this Fleſhy Subſtance is compoſed, may then be eaſily ſeen in a thin tranſverſe ſection laid before the Double Microſcope, as at Fig. 72; and we ſee plainly why all was obſcure before. The Veſſels of this part do not contain a watery or colourleſs liquor, as thoſe of the others; but the eſſential Juice of the Plant: whereon depend its taſte, ſmell, and virtues. All theſe are, in a manner, centered in this, and in thoſe proceſſes of it which run in amongſt the Blea; theſe uſually break off in ſeparating this ſubſtance from the reſt; therefore they are not figured here. This Juice is thick, and coloured, and ſo ſlowly leaves the Veſſels, even in the thinneſt ſections, that the tops of them continue covered over, and the interſtices as well as their cavities filled with it; ſo that all appears one opake maſs.

WHEN a ſoft water has penetrated this Juice, and a ſolution of alum hardened the coats of the Veſſels which contain it, ſpirit of wine, without affecting them, will, in a great meaſure, diſſolve, and abſorb it; then the Veſſels appear diſtinctly, as in Fig. 72. They are round, they have large cavities, their Coats are ſupported by woody Fibres, and cluſters of the like Fibres run up in all the ſpaces which thoſe round bodies leave in touching one another. Theſe are larger than in the other parts of the

Plant; where the Veſſels themſelves being weak, preſs more upon one another.

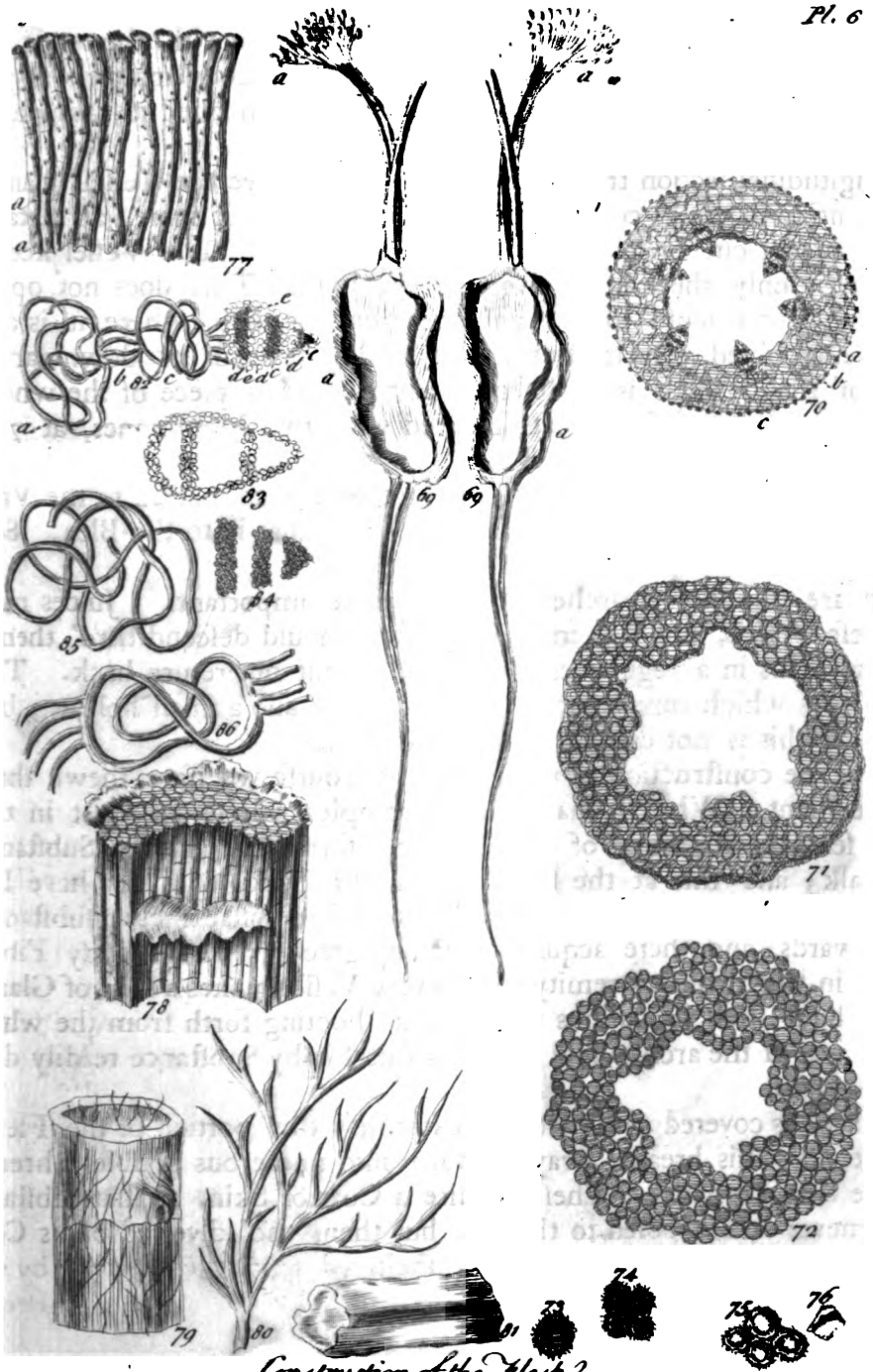
At Fig. 73, is repreſented the mouth of one Veſſel, with the ends of the woody Fibres. At 74, a ſpace filled with the woody matter: at 75 the ſame ſpace empty; and at 76 the ſubſtance which filled it; which is ſhewn alſo greatly enlarged at 81.

In a longitudinal ſection treated the ſame way, we ſee the Veſſels plainly and diſtinctly in their courſe: they are jointed, as it were, at certain diſtances, but not cut or pinched in at thoſe Joints. The Veſſel keeps on its courſe; only there is a Valve at every Joint. This does not open in the center, but is looſe for a ſmall ſpace on one ſide, where it is capable of being raiſed a little, but not of falling inwards or downwards. One Bed of theſe Veſſels is repreſented at 77; and a piece of the whole thickneſs, conſiſting of five Coats covered with two Membranes, at 78: a piece of one Veſſel, with its Valve vaſtly magnified, at 79; and the woody Fibres which ſupport it at 80. This part is connected to the Vaſcular Series by ſmall oval Veſicles or Glands; as that is to the Blea. See 77, *a a*.

These are minute reſearches, but they are important. Juices may aſcend theſe Veſſels, but it is impoſſible they ſhould deſcend thro' them: or they may paſs in a regular courſe one way, but not return back. The woody Fibres which run up between theſe, have alſo a ſmall hollow; but the Juice in this is not coloured, as in the Veſſels.

This is the conſtruction of the Fleſh: its courſe we have ſhewn thro' the whole Plant. When it has made a compleat Circle, or Coat in the Root, it ſends up a portion of itſelf, which forms the Fleſhy Subſtance in the Stalk; and this at the Head, when the Rinds and Blea have left it, going off in Fibres and Petals, ſwells into a ſomewhat thicker ſubſtance, arched inwards, and there acquires a ſtrong green. The woody Fibres terminate in this ſwoln extremity; and every Veſſel makes a kind of Gland, winding about itſelf in various forms, and ſhooting forth from the whole upper ſurface of the arch a new Pith; as this Fleſhy Subſtance readily does in other places.

This Pith is covered only with an extremely thin portion of the Fleſhy Subſtance, and this breaks away upward into numerous double Threads, which are the Filaments. Theſe acquire a Coat or Skin, as that ſubſtance does whenever it is expoſed to the air: but then, tho' diveſted of its Coat, it is ſtill in the body of the Flower ſheltered from the weather by the Petals;



Construction of the Flesh?

Petals; and therefore this Coat is white. The termination of each of these pairs of Fibres or Threads, which are inclosed in the white Membrane, is in a globule of an oval form: the two are placed near one another within the common Membrane; and thence the Anthera is double. In each globule of the Farina there is a minute portion of the Fleshy substance turned round upon itself, the end being too weak to pierce the shell of the globule. These are the original Plantulæ Seminales, which being covered by the waxey matter obtained from the Nectaria, and afterwards lodged in the Seeds, grow into perfect Plants.

CHAP. XXIV.

Of the COURSE and STRUCTURE of the PYRAMIDAL CLUSTERS.

THE Clusters of Vessels which have been described, as having their place within the Fleshy Substance in every part of the Plant, come next to be examined. Tho' they are in some degree immersed in it, they are no absolute part of it: they are a distinct system; and they consist of certain arrangements of colour'd Vessels covered and separated by white and pellucid ones. We have seen these in the various sections of the Plant, whether we cut the Fibre, the body of the Root, or the parts above the surface. They are not peculiar to the Flower Stalks, for we find them also in those of the Leaves: therefore they are not destined to become organs of fructification; but are nutricious Vessels only: and they are universal in the Plant.

IT is in the body of the Root we are to look for their origin; and there we find them produced from the coloured Vessels of the Fleshy Substance.

IN certain places these form a kind of knots. See Plate VI. Fig. 70, Letter e. One of these, separated and more enlarged, is also represented at Plate VI. Fig. 82. From these knots, 82, *a*, run little Fibrils, *b*, which are so many real Vessels, and in which we can see in the fresh Plant a coloured Fluid: these, at a small distance, form new knots, Fig. 82, *c*, from whence proceed the several coloured Vessels of these Clusters, Fig. 82, *d d d*; and from their own sides are produced, in the same manner, those pellucid Vessels which surround them, Fig. 82, *e e e*. At 83 is repre-

ſented the white part of the Cluſter ſeparated; and at 84 the green. At 85 the original Knot; and at 86 the Veſſels running thence, and producing the ſecond.

THE whole Cluſter is pyramidal, when it is perfect: and might appear to the incurious only one Veſſel, 70, *c*. It has been ſhewn how the Cluſter conſiſts of many; and it is for this cauſe that in maceration, or even in a diſeaſed ſtate of the Plant, the Cluſters often break, and ſeparate.

CHAP. XXV.

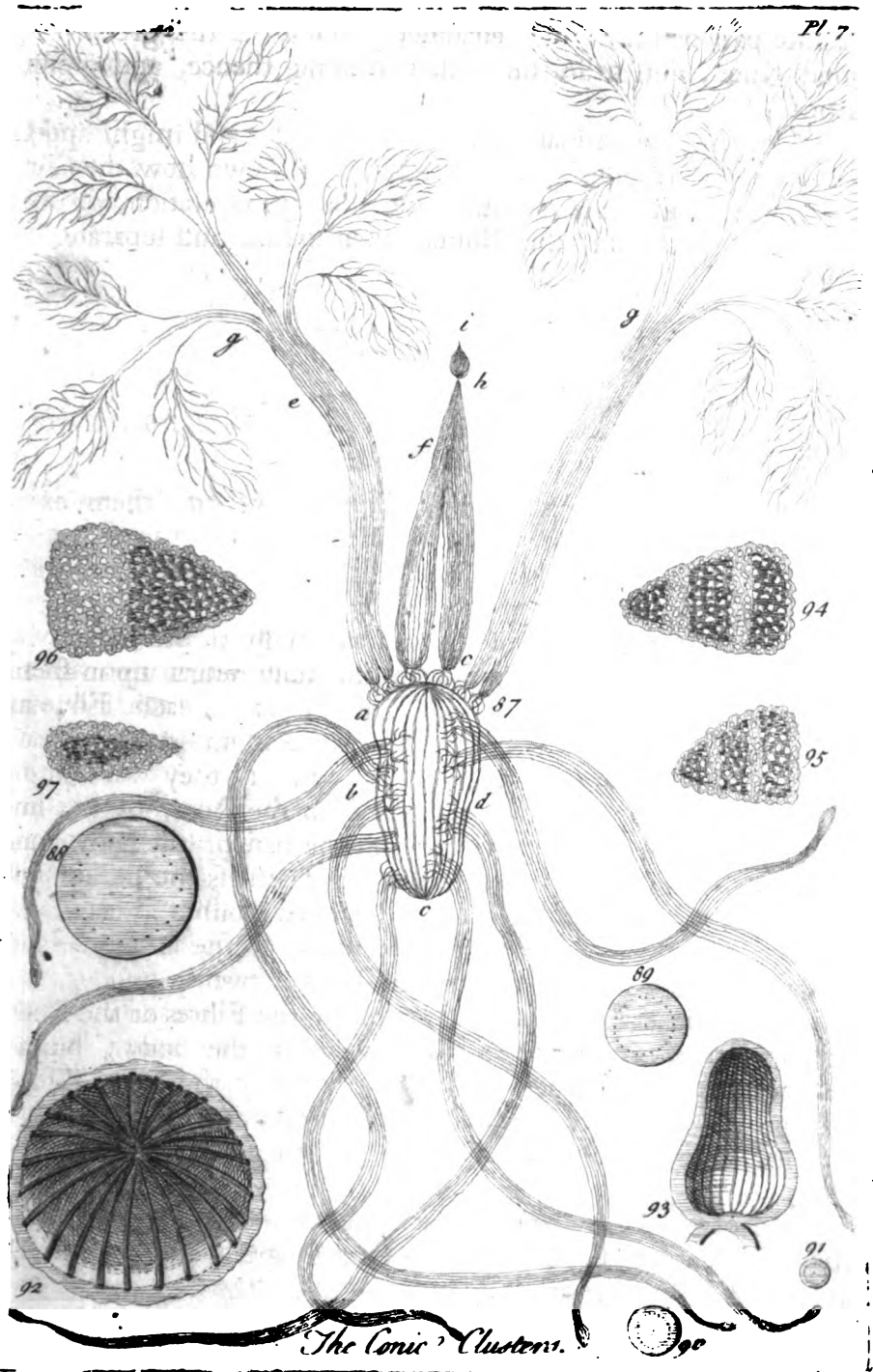
The COURSE of the PYRAMIDAL CLUSTERS.

IF we purſue the courſe of the ſeveral Cluſters, we find them exhibiting, in the macerated parts, a kind of Skeleton of the Plant; if that name may be given to things ſo little ſolid. This is repreſented in Plate VII. Fig. 87.

THERE are twelve of theſe Cluſters in the body of the Root, *a*; and ſix in every Fibre, *b*. The twelve in the body return upon themſelves at the crown, and at the baſe, *c c*; and the ſix in each Fibre are not continuations of theſe. The Fleſhy Subſtance comes between, and they are produced from its ſurface in the Fibre, juſt as they were in the body of the Root; but communicate with thoſe of the Root, by the minute Veſſels *d*. They round its end as they did the baſe of the body; and return into themſelves at the crown: ſo that in ſtrictneſs the ſix are only three, and the twelve only ſix. They are counted double, becauſe we ſee them going and returning. In each Footſtalk of the Leaf there are twelve of them, *e e*; and in the Stem of the Flower twenty-four, *f*.

ALL theſe are produced exactly as the Cluſters in the Fibres of the Root: they are not continuations of the original twelve in the body; but are formed from the Fleſhy Subſtance of the part wherein they lie. This is peculiar in Vegetables, that one portion of their ſubſtance can produce all the others; and it is from this reaſon that all the parts are capable of growth.

AT the crown of the Root theſe Cluſters return in an arch, into themſelves. The Footſtalks of the Leaves divide each into three parts at the head; from which ſeveral portions the partial Leaves grow: and in each of theſe are four of the Cluſters, the twelve of the Stalk being regularly divided



The Conic Clusters.

divided among them, *g g*. Theſe run up the middle Rib of each Leaf, ſending off branches all the way into the ſide Fibres, till they have thus exhauſted their whole ſubſtance.

THUS far they are like the Nerves of Animals; that they do not diminiſh as they come toward the extremities, otherwiſe than by ſending off part of the Veſſels which compoſe them. Theſe always go off accompanied by ſome of the pellucid Veſſels; and the Cluſter diminiſhes only as they are ſent away: for each particular Veſſel is all the way of the ſame diameter.

IN the Flowerſtalk, tho' they be diſtinctly four and twenty at the baſe, that entire number is not to be counted in ſections of the upper part, for they run one into another when preſſed into a narrower compaſs at the neck: from this part they continue themſelves into the Receptacle. They come nearer together as the diameter of the Stalk diminiſhes at the top, *h*, and finally run up to the extreme top of the Receptacle itſelf, *i*.

IF we continue to cut tranſverſe ſections of the Stalk upwards 'till we come to the Flower; and then purſue the ſame courſe, cutting thro' the Flower and Receptacle tranſverſely, by a multitude of very thin ſections, we by degrees ſee the two outer Petals, then the three inner ones, fall off; and when nothing remains but the Nectaria, Filaments, and Seed Veſſels, ſtill every ſection preſents theſe Veſſels very diſtinctly. See Fig. 88, 89, 90, 91, repreſenting theſe various ſections. Tho' they were crowded together in the neck of the Stalk, they were never confounded in their ſubſtance; they ſeparate again in the Receptacle, and the fleſhy part of that being white, and theſe Veſſels dark, we ſee the full number of twenty-four very diſtinctly. Even when the Filaments are all fallen off, and the remainder of the Plant is only the collection of Seed Veſſels, theſe twenty-four Cluſters, tho' very minute, are ſtill perfectly to be diſcerned; and in the ſection which gives the very ſummit, where the Seed Veſſels diſunite and fall off, theſe Veſſels are ſeen returning in ſo many arches upon themſelves, and continuing their courſe down toward the Stalk. See Fig. 92. Their courſe upward in the Receptacle is alſo ſhewn at 93.

As the diſpoſition of the green and white Veſſels in theſe Cluſters differs in the ſeveral parts, they are repreſented diſtinctly in this Plate: Fig. 94 is the Cluſter in the Flowerſtalk; 95 in the body of the Root; 96 in the Footſtalk of the Leaf; and 97 in the diviſions of that Footſtalk.

CHAP.

CHAP. XXVI.

Of the PITH.

EVERY thing being now cleared off from the macerated Plant, there remains only the Pith; a ſubſtance which has been thought very important, but which a more critical enquiry robs, in a great meaſure, of that character. Its diſpoſition and courſe in the entire Plant, is repreſented in Plate VIII. Fig. 98.

WHATEVER perfect part of the Plant we cut, we ſee this: it always occupies the center; but it no where reaches the extremity of the part wherein it lies. In the Fibres it is a column, which goes very gradually diminiſhing from the larger to the ſmaller end, *a a*. But it neither reaches the body of the root, nor the extremity of the Fibre. We have ſhewn how it lies in the head which makes the end of the Fibre: at the part near the body of the Root it is terminated in the ſame manner: the Vaſcular Series and Fleſhy Subſtance in each of thoſe parts ſurround it.

IN the Body of the Root there is another column of Pith, *b b*, if it may be ſo called; but this is very irregular at the ſides; and this is in the ſame way terminated by the arch which the Fleſhy Subſtance makes at the baſe and crown, and by the Vaſcular Series. This Pith of the body of the Root has no connection whatever with that in the Fibres.

IN the Footſtalks of Leaves there is no Pith. The Leaves are not perfect parts, but aſſiſtant organs.

IN the Flowerſtalk it forms another column, *c c*; largeſt at the baſe, and ſmalleſt at the neck, where it is pinched in at the origin of the Flower, and there is again finally terminated. But tracing the Plant up into the Receptacle, we ſee there another column of it, *d d*, ſhort, and in form of a cone, with a broad baſe running ſuddenly to a point. This has no more communication with the Pith of the Stalk than that has with that of the Root. All the Parts of the Plant have a Pith; but it is detached in each: and, therefore, in repreſenting that of the entire Plant, we muſt place it in order, in four diſjointed pieces. The termination of the uppermoſt of all is juſt under the arch made by the Cluſters of Veſſels at the ſummit of the Receptacle.

HAVING ſeen its courſe and place, we are next to conſider its conſtruction.

IT

It is plainly formed by juices thrown out from the inner ſurface of the Fleſhy Subſtance of the Plant, and from the ſurfaces of the ſeveral Conic Cluſters of Veſſels. Theſe Juices hardening on thoſe ſurfaces form Veſſels. Thus the Pith becomes Vaſcular: and as only the ſurfaces of theſe vaſcular Cones, and the intermediate inner ſurface of the Fleſhy Subſtance give it origin, it muſt of neceſſity be circumſcribed within the bounds of the hollow which they form. Thus it is utterly impoſſible the Pith of one part ſhould run into the Pith of another: and what at firſt appeared ſo ſtrange in its courſe, is the neceſſary reſult of its conſtruction. A tranverſe ſection of the Pith of a Fibre of the Root, cleared from all the other ſubſtances, is repreſented at Fig. 99; and a like ſection of the Pith of the Flower Stalk, at 100. The mouths of the cells are empty or full of Juice as the knife has chanced to paſs thro' an empty or a full part.

The Veſſels of the Pith being covered the moſt of any in the Plant, from the air, become thence the whiteſt and moſt tender. They are very numerous, and are jointed in a manner at once ſingular and highly elegant, Fig. 101. The Cells are of nearly an equal length and thickneſs; ſo that the joints are ſhorter than in the Blea, whoſe Cells they otherwiſe, in ſome degree, reſemble: but there are no Veſſels upon them. The Blea conſiſts of Cells and Veſſels; this part of Cells alone. The diviſion between Cell and Cell are of a ſpungy Membrane, full of ſmall holes, which are ſhewn at Fig. 102, a little more magnified. Through theſe the liquor forces itſelf in little drops, ſo that the whole Veſſels often appear full as it were of ſtrings of minute beads.

These Veſſels ariſe principally from the part of the ſurface of Fleſhy Subſtance which makes the arch at the baſe of that portion of the Plant wherein they are formed. See Fig. 103, *a b*; and from the arches of the conic Veſſels there. From this part they run to the arch at the top in a tolerably ſtrait courſe; and there are again inſerted in the arches of the ſame parts. Some Veſſels of a like kind and form, and which make a part of the ſame ſubſtance of the Pith, are alſo ſent off from the ſides of the hollow Cone formed by the inner ſurface of the Fleſh, and Conic Cluſters; and theſe in the ſame manner run ſtrait upwards, and terminate in the arch at the top. Fig. 104 repreſents a ſmall piece of the Pith, with the Veſſels greatly magnified, to ſhew the courſe of the chained globules of Juice: at 105 is a piece of the ſingle Veſſel viewed with the greateſt magnifiers, with the Membrane ſeparating it into Cells: and this Membrane, with its irregular apertures, at 106.

The

THE moſt extraordinary part of the Pith is that in the Receptacle, Fig. 107, 107. Cloſe under this, that is, at the head of the Flower Stalk, the Fleſhy Subſtance makes a fair arch, returning upon itſelf ſo as to ſtop and terminate the column of Pith within it there, 107, *a a*. From this part it ſends up each way a portion of its upper ſurface, *b b*, which makes the Cone of the Receptacle; and within this is form'd a new Pith, with new Series of Veſſels. A portion of the Pith of the Receptacle is repreſented ſeparately at 108.

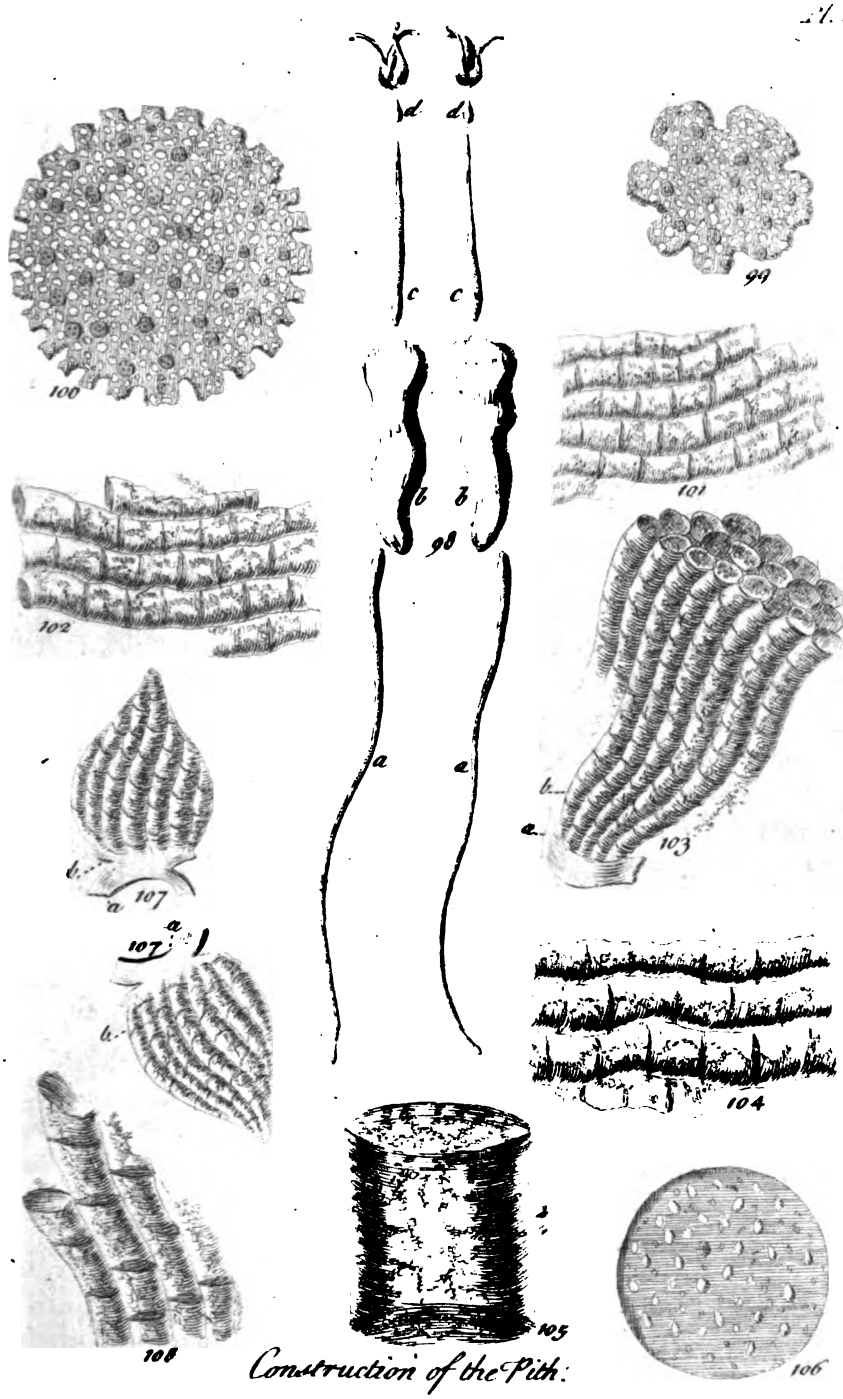
THE ſubſtance of the Seed Veſſels is formed of the Blea which this Fleſhy Cone ſhoots out on the ſurface; and the Pith of the Cone begins and terminates in it.

AFTER examining, in this manner, the two Barks of the Hellebore, we continued the ſame courſe of enquiry to the like parts of other Plants: and theſe appeared to be, in all eſſential articles, the ſame with the firſt. In the ſame manner I have purſued the courſe and ſtructure of the Blea, the Vaſcular Series, the Pith, and the reſt, in ſeveral other Plants; and find that the generality have them all; and none have any more: their place is the ſame in all, and their courſe the ſame, as alſo is their ſtructure. Therefore what we have ſeen here to be the compoſition and conſtruction of the Hellebore, we have a right to believe is the Vegetable Structure in general. If there be variations in ſome kinds, they are ſlight; and the general ſyſtem is not affected by them, any more than the generical characters are by ſpecific diſtinctions.

IT has been thought peculiar to the Pith, in certain Trees, that it occupies a large ſpace in their young Shoots, and ſhrinks ſo as almoſt to diſappear, as the ſame parts grow more confirmed in their conſtruction: but the preſent account of that part will, in ſome degree, explain this wonder; nor will the obſervation be applicable to the Pith alone.

YOUNG Shoots draw from the earth abundant moiſture; for out of that is to be formed the Vegetable Syſtem: but as a great deal is for this reaſon taken into the Veſſels of the Plant; a great deal muſt be alſo diſcharged from them. This is done outwardly by the Hairs or downy matter common on young Stalks; and inwardly, tho' in a leſs degree, by the Pith. This being the great uſe of thoſe two parts, they are eſſential to the Plant in that ſtate; but they become unneceſſary afterwards: and therefore, in many Plants, and particularly in ſeveral Trees and Shrubs, the young Shoots have a large Pith within, and a thick downy covering on the ſurface; whereas, when they are grown harder, they become ſmooth and ſolid.

THESE



Construction of the Pith.

THESE obſervations, joined to what we have juſt ſeen of the inner ſtructure of the ſubſtances, will teach us what parts are eſſential to the Vegetable Syſtem, and what only accidental; what abſolute; and what merely temporary. We ſhall thus diſtinguiſh the importance of the ſeveral parts, and be led forward regularly in the courſe of our great enquiry.

CHAP. XXVII.

Of the LIFE of PLANTS.

BY Life in Plants, we mean that power whereby they grow: receiving nouriſhment, and advancing from the minute and tender ſtate wherein they lay within the Seed, to heighth and ſtrength; extending and diſcloſing regularly their ſeveral parts; and in the end forming new Seeds for a ſucceeding race. This power all Vegetables plainly have; nor are their inſtances of life limited to theſe alone: for ſome have motion in their ſeveral parts, the Sleeping and Senſitive Plants in their Leaves and Footſtalks, and moſt of the Syngeneſious Tribe in their Flowers.

THE Seat of Life I apprehend to be in that part I have called the FLESH of the Plant; and its powers to ariſe from a motion in the Juices of that part. This motion ſeems to be peculiar to its Juices, and not to have place in thoſe of any other part of the Plant; it appears alſo by its ſeveral ſtates and degrees, to give Health, Vigour, Sickneſs or Decay, to the entire Vegetable.

THAT this ſubſtance, the Fleſh of Plants, is the ſeat of their Life, appears from theſe certain obſervations: that no Plant is deſtitute of it, tho' occaſionally one or other of the ſeveral other parts are wanting; and that when this part is deſtroyed, the Plants inevitably dies: whereas, while it remains, there is always life; and there reſides in it a power of producing, by the mere motion of its Juices, all the others. This we evidently ſee in Seeds, whoſe Corculum is no other than a regular piece of this ſubſtance; and tho' leſs obviouſly, yet not leſs certainly, in the growth of Cuttings.

THERE is no ſtate wherein the Veſſels of this part are deſtitute of their proper Juices: theſe require moiſture, to make them able to flow in the Veſſels, and heat to put them into motion. When they want theſe they coagulate in the Veſſels; but they retain a long time the original power of being put in motion by thoſe aſſiſtances. It is for this reaſon the heart of

the Seed, which is a piece of the Fleſh of the parent Plant, does not grow while kept out of the ground; but ſhoots when planted: the want of moiſture prevented its growth before; for when Seeds ripen, the Veſſels of the Plant which fed that part where they are formed dry up. Yet we ſee they are capable of growth even there, when accidents give the means: thus, in rainy ſeaſons, the Seeds of many of the Graſſes ſhoot in the Ear.

As Seeds are capable of being kept dry a long time, yet with the latent power of Life unhurt. So it is with thoſe Roots which we take up at certain ſeaſons, and may keep out of the earth, for ſeveral months, nay years. The philoſophy of both is the ſame; for Seeds and Roots differ more in magnitude than nature. In each there is a portion of the Fleſh of the original Plant, which forms a Caſe or Shell, defended from injuries by its outer Coverings; and has Veſſels returning upon themſelves, in form of the Veſſels of animal bodies, tho' wanting the diſtinction of Arteries and Veins. The Juices in this ſubſtance may coagulate and ceaſe to flow, and yet retain the power to do it on proper aſſiſtance: and ſo long the Seed or Root enjoys a ſtate of capable, rather than actual life. The Seed is as the egg of an animal, which will never come to growth without the proper helps; tho' it will, for a certain time, retain the power of life. The Root we take out of the ground, for certain months, would remain during the ſame time if left in the earth in a ſtate of reſt: a condition not very unlike that of thoſe animals which ſleep the winter: Juſt ſo much Life remaining as to preſerve the vegetable character; tho' without performing any of its functions.

On the circulatory motion of the Juices in theſe Veſſels of the Fleſh of Plants, depends entirely their growth, and the diſcloſing of their parts: yet there is not a neceſſity that the motion of returning Juices be carried to the extremities of all thoſe parts. The vigour of a certain ſyſtem of circulation will give growth to detached parts of the Fleſh which riſe far beyond it. This is ſeen in the formation of the Filaments in the Flowers of Plants; for there is no return of their Juices. The force of growth in them ariſes from a ſyſtem of circulation lodged much lower in the Plant; and this ſyſtem of returning Veſſels, is ſometimes ſingle, ſometimes repeated. This will be explained at large in the ſucceeding Chapters, where we ſhall illuſtrate the general doctrine by particular inſtances. It may be ſufficient to obſerve here, that the Winter Aconite, to be deſcribed hereafter, ſhews an inſtance of a ſingle circulatory ſyſtem; there being no returning

turning Veſſels except in the Root: and the Anemone of a double order; one in the Root, and a ſecond in the lower part of the Stalk.

CHAP. XXVIII.

Of the FORMATION of a PLANT in the FARINA.

IT will be proved by numerous and plain facts, that the FLESH of Plants is the eſſential Vegetable Matter; and it has been ſhewn already, that the termination of this part is always in the Filaments of the Flower, upon whoſe ſummits ſtand the Antheræ, containing that Farina, which all know to be neceſſary to the impregnation of the Seed; tho' it has not been yet ſhewn truly in what manner.

BY tracing the courſe of the Fleſh of the Plant up to the Filaments of the larger Flowers, we find that the Veſſels of this part diminiſhing there, run up in numerous diſtinct cluſters to the top of each Filament. The Coat of the Filament ſpreads into a Veſſel called the Anthera, and theſe cluſters of Fleſhy Shells line it throughout: there continuing to grow, they raiſe its internal ſurface into little Bliſters all over: the Coat of the Anthera is double; and there is a ſpungy matter between the Membranes: theſe cluſters of Veſſels alſo run between the two. And they now raiſe the inner Coat from the outer, in form of thoſe Bliſters; which contracting at the neck where they riſe, and being filled by Juices diſcharged into them from the Spungy Subſtance of the Anthera, ſwell; and each becomes a globule of Farina. The cluſter of Veſſels, or particle of the Fleſh of the Plant, when it has grown ſo as to reach the top of the little Bliſter, not having ſtrength to pierce it, is bent round, and continues to grow till its extremity meets the part where the cluſter entered the globule. All is naked, tender, and delicate here; the Veſſels as they meet inoſculate, and there is thus formed an oval ring of the Fleſh of the Plant, containing many of its Veſſels, returning into themſelves.

THIS is the rudiment of the future Plant. Theſe Veſſels have their Juices, and they form a ſmall ſyſtem, containing all that is eſſential to the ſpecies, capable of preſerving themſelves dry; capable alſo of growing with the help of heat and moiſture; and capable of producing all the other parts, and forming an entire Plant of the ſame kind; the extremities of whoſe Fleſh Veſſels ſhall form again ſuch other ſyſtems; and this with-

out end. This is plainly the manner of Vegetable Production and Increaſe: there is no Generation, but ſimply a continued Growth.

As ſoon as this little ſyſtem of vaſcular Fleſh is formed, the intent of Nature in the parent Plant is anſwered in that part. The Juices from the ſpungy ſubſtance of the Anthera are derived from the Veſſels of the Nectaria; and are of the nature of wax: they ſurround this little ſyſtem; they defend it from injuries; and the Anthera then drys, and burſts open; the little globules of Farina drop off from the inner Coat of it, their ſmall necks having dried away: and thus the globule falls off upon the Stigma of the Flower. That part is always wet; the thin ſkin of the globule burſts, and the Plantule, or piece of vaſcular Fleſh, falls out, encompaſſed with this waxy matter, which, not mixing with the water, appears like ſolid atoms.

SURROUNDED by this indiſſoluble matter, the ring of Fleſh makes its way into the Seed-Veſſel; where there is always an open way for it into a Seed: the ſame opening at which the young Plant afterwards burſts forth; and which is always viſible. The Seed, which is formed of the Pith of the Plant, ſurrounded with its Coats, was originally an exudation of this very Fleſhy Subſtance, its Juices therefore are happily ſuited for the nouriſhment of this minute particle of the Fleſh; and it is no ſooner lodged in the Seed, than it begins a peculiar kind of growth. There is moiſture; and there is warmth enough in the air. The Juices in the Veſſels of this Ring have never yet congealed: they move; and it muſt be circularly, for their valves admit of no return. Their tender coats receive, thro' the ſmall apertures of their yet ſpungy ſubſtance, abundance of this appropriated fluid, they ſwell till the ring almoſt cloſes, being preſſed together: and the ſame open texture of their Coats gives way to extravaſation. A few looſe threads of Pith are ſhot inward, and Conic Cluſters ſoon appear.

THE origin of theſe is in a horizontal direction; but they ſoon aſcend; the Juices get coats as they riſe, by the mere hardening of the ſuperficial part, and they return upon themſelves, becauſe they are too weak to pierce the Fleſh where it makes the arch of the ring. Veſſels are added to Veſſels, by the growth of the Fleſh; and thus what was a ring becomes a ſhell, and is the ſhell or coat of Fleſh of the ſucceeding Root, which ſhoots next its two SEED-LEAVES.

ALTHO' the Conic Cluſters do not, in their own Veſſels, pierce the Fleſh, there riſe from them thoſe tender hollow threads of communication which we have ſeen in the preceding Figures; and from the extremities of

of theſe, where they pierce the Fleſh, ariſe new Conic Cluſters, which do not form returning ſyſtems, but ſpread themſelves thro' the ſubſtance of the Seed in the rudiments of the Seed-Leaves. Theſe have been taken for a peculiar ſyſtem of Roots.

THE inner ſubſtances being thus formed, and ſtill redundant Juice ſupplied to the Plantule, its extravaſated Juices firſt form the Vaſcular Series. There remains ſome of the waxy matter of the Anthera among the proper Juices of the Fleſh-Veſſels; and this being moſt unlike the reſt, is firſt thrown out: it is puſhed forth with ſome violence; it continues to follow the courſe of the Plantule, and conforming itſelf to its ſhape, and the ſeveral ſtreams hardening at the ſurface, the Vaſcular Series is formed: the two Membranes being only extenſions of the ſubſtance of the Coats of theſe Veſſels, reaching from one to the other, and keeping all together.

THE waxy fluid being ſeparated, the next which is extravaſated forms in the ſame manner the Veſſels of the Blea; and the extravaſations from theſe give origin to the Veſſels of the two Rinds. Thus is there lodged within the body of the Seed, a piece of the eſſential ſubſtance, or Fleſh of the original Plant, which has there formed for itſelf, by the natural courſe of the Juices, all its coverings. The purpoſe of Nature being ſo far anſwered, in the common ſtate of things, no more is done there. The Juices of the Stalk ceaſe to flow into the Seed-Veſſel, the Seeds harden, and they are fit for ſowing. Every one containing a perfect portion of all the ſubſtances of the future Plant, needs only due warmth, and that moiſture it no longer receives from the Seed, to continue growing.

THUS far all Vegetable Nature, ſo far as I have examined, is regular; the formation of the Plantule in the globule of Farina, being alike in all: but it is not ſo in the ſucceeding periods, for Seeds differ in the conſtruction and arrangement of that pulpy matter in which the Plant is lodged; and, therefore, while the generality riſe with two Seed-Leaves, as the Turnip, ſome have only one, as the Corn and Graſs kinds; and others have ſeveral, as the Pine. Therefore it will be neceſſary, in tracing the Seed to the Plant, to fix upon one inſtance, and the more common the Plant be the better. I have choſen the Radiſh, becauſe its Seed is always at hand, becauſe it very readily grows, and becauſe the parts of the entire Plant are large and conſpicuous.

To trace the whole progreſs of Vegetation, I ſhall take this inſtance; in which, howſoever minute the reſearches may appear, it will be eaſy for every one to follow them: and, to leave no part unconſidered, it will be beſt firſt to conſider the Plant perfect, and in flower; to trace the formation

tion of a globule of Farina from that Plant; and following the courſe of Nature, to obſerve the whole progreſs of that Farina to a perfect Plant again.

THE formation of the Farina of the Radiſh, is repreſented in the annexed Plate; and will ſerve happily to illuſtrate the general doctrine juſt laid down, by a familiar inſtance.

CHAP. XXIX.

The FORMATION of the new PLANT in the FARINA of a RADISH.

THE common Garden Radiſh, in its full growth, is repreſented Plate IX. Fig. 1. The Stem of this is compoſed as the Stalks of other Plants, of the ſeven conſtituent ſubſtances before deſcribed; and their proportion in this ſpecies is ſhewn in a tranſverſe ſection of the Stalk, Fig. 2, cut from the part near the ground. They have the ſame diſpoſition in the Footſtalk of the Flower, Fig. 3; and at the ſummit of that Footſtalk they ſeparate one from another, to form thoſe parts of the Flower which are their natural terminations.

A FLOWER of the Radiſh is repreſented at Fig. 4, enlarged by the Microſcope, to ſhew the ſeveral parts diſtinctly; and at Fig. 5 the ſame Flower, with its Footſtalk, cut open, and torn from the top into its ſeveral parts, to ſhew how they go off from one another. The Letters *a b c d e f g*, mark the ſeven conſtituent parts; *a* the outer Bark; *b* the inner Rind; *c* the Blea; *d* the Vaſcular Series; *e* the Fleſh; *f* the Conic Cluſters; and *g* the Pith. Theſe terminate diſtinctly in the ſeveral parts of the Flower.

WE ſee, at Fig. 4, that the entire Flower has its Cup *h*, two outer Petals *i i*, and two inner Petals *k k*. Within theſe we ſee the ſix Filaments; four of which are longer, and two ſhorter, *n n*, crowned with their Antheræ; and in the midſt of thoſe the top of the young Seed-Veſſels *o*. The ſame parts are more diſtinctly ſhewn in the divided Flower *p*; and there we ſee alſo two other parts, which could not be diſtinguiſhed in the entire one; becauſe they are hid within the other parts: theſe are four protuberances within the Cup, and the Receptacle of the Flower. The four protuberances are thus arranged; two ſtand between the rudiment of the Seed-Veſſel

Veſſel and the two ſhorter Filaments, *l l*, 1; and the other two protuberances between the longer Filaments and the cup; theſe are marked *l l*, 2. The Receptacle *m m*, is a conic, whitiſh, ſpungy, body, riſing from the crown or ſummit of the Footſtalk, and affording a kind of baſe to the internal parts.

We ſee thus there are ſeven parts in this Flower as in others, ariſing from the ſeven conſtituent ſubſtances of the Stalk; and they are produced from them in this manner.

The outer Bark, Fig. 5, *a*, forms the entire Cup *b*, which being carefully pulled off, takes that Bark with it; the inner Rind, *b*, ſpreads into the two outer Petals *i i*; the Blea, *c*, forms the two inner, *k k*; the Vaſcular Series, *d*, terminates in the four protuberances in the Cup *l l*; the Fleſh of the Plant, *e*, ſplits into the Filaments *n n*; the Conic Cluſters of the Veſſels form the Receptacle, *m m*; and the Pith, *g*, runs up into the rudiment of the Seed-Veſſel *o*.

Of all theſe parts the moſt eſſential are the Filaments. We have ſeen that the Fleſh is the ſeat of Life in the Plant; and theſe being the terminations of that ſubſtance, have the ſame quality: every piece of them, if it can be preſerved from decay, is ready to grow into an intire Plant; for it can produce its lining of Pith, and all its coverings, from the extravaſation of its own Juices; and as its ſubſtance will naturally terminate in other Filaments, theſe its coverings will form the ſeveral parts of the Flower for their defence, and the Seed for their reception.

The Receptacle of the Flower, ſeparated from the other parts, is repreſented at Fig. 6, as it appears enlarged by the Microſcope. This is a kind of great Gland. It is formed of the white ſpungy matter of the Conic Cluſters, united into one maſs; and it is in this the Fleſh of the Plant begins to contract its Veſſels, to diminiſh the intermediate ſpungy matter, and to divide itſelf into Cluſters. See Fig. 7: where this is, in ſome degree, repreſented in the ſplit Receptacle, tho' it is difficult to ſhew it diſtinctly. Into this Receptacle alſo are ſent certain white very ſmall Veſſels, filled with a pale yellowiſh matter from the protuberances, Fig. 5, *l l*, which terminate the Vaſcular Series.

The Vaſcular Subſtance of the Fleſh of the Plant, being now diveſted of the intermediate ſpunge, divides at the ſurface of the Receptacle Fig. 6, 7, *p p p p*, into a number of detached parcels, which may now be conſidered as ſo many cluſters of pure Veſſels continued from the Fleſh of the Stalk, but greatly diminiſhed: theſe riſing again, at the ſurface of the Receptacle, become extended into long, ſlender bodies, called the Filaments; and

and as they do not pierce the ſkin of the Receptacle, but raiſe a portion of its ſoft ſubſtance with them, they grow up covered with this as a ſkin.

THUS is formed the Filament, Fig. 8, which conſiſts of a quantity of the Fleſh of the Plant, purely vaſcular, covered with a reticulated looſe ſkin, which is part of the white matter of the Conic Cluſters raiſed into the Receptacle.

THUS is formed the Filament; and into its baſe run thoſe fine Veſſels which we ſee ariſe from the protuberances terminating the Vaſcular Series; and running thro' the Fleſh of the Receptacle they go up the very ſubſtance of the Filament, and accompany its Veſſels to the extremity. The ſubſtance of the Filament is to form the embryo Plant; and the waxy Juice in theſe Veſſels is to cover and defend it. An unripe Filament is repreſented at Fig. 9. In the ripe Filaments we find the ſummit formed into a regular oblong Anthera, compoſed of two cylindric tubes, each with its proper groove for burſting, and faſtened to the tender top of the Filament toward its lower end, Fig. 10.

THE Anthera is thus formed. Toward the ſummit the Filament becomes ſmall, and at its very point there is another minute Gland, ſomewhat opake in hue, and full of cluſtering Veſſels. This is repreſented vaſtly magnified at Fig. 11. A ſmall cord ſurrounds it, formed of the thickned coat of the Filament; and within, all the cluſters of Fleſh Veſſels become again much ſmaller. They are here at their extreme fineneſs. From the ſummit of this, Fig. 11. the coat of the Filament expands, and grows from the cord, 2, each way into a cylindric tube; and theſe two tubes form the compleat Anthera, Fig. 12. which tho' underſtood to be only fixed upon the Filament, is in reality its proper termination. The Figure at 12 repreſents the Anthera ripe, but entire: that at 16, ſhews it burſt for the diſcharge of the Farina: the intermediate Figures, 13, 14, 15, ſhew its progreſs from the Bud of the Flower to ripeneſs.

THE outer ſurface of theſe two cylinders which compoſe the Anthera, is all we have yet ſeen. It will be proper to cut one of them aſunder tranſverſely, to examine their conſtruction. This gives us a view of the inſide of the cylinders, which, according to the age of the Anthera, or its degree of ripeneſs, appear in different conditions. In a very young one, taken out of a ſmall Bud or Flower, the coat of the Anthera is ſeen to be double, with Veſſels between, Fig. 17, and with a ſmall hollow. In one yet more advanced, Fig. 18, there appear Bliſters in the cavity. In one yet nearer maturity, Fig. 19, theſe Bliſters ſhew a regular elliptical ſhape, and are ſo raiſed from the ſurface as to fill all the cavity. Theſe Bliſters

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are now globules of Farina. To know how they are formed, we muſt open one of the Antheræ in a ſtate of half ripeneſs, and then of perfect maturity.

When we open in this manner a half-ripe Anthera, we find that between the two Membranes of the cylinder there run innumerable little cluſters of the Fleſh Veſſels; that is ſo many portions of the Fleſh of the Plant, diveſted of all encumbering matter, and formed of Veſſels wonderfully reduced in ſize. All theſe are regular portions of the Fleſh of the Plant, which have paſſed thro' the Receptacle, and have been again reduced in ſize at the top of the Filament, but which are yet entire, and contain, minute as they are, their proper Juices, and continue to grow.

In the half-ripe Anthera we find theſe little portions of the Fleſh of the Plant, every where ſtriking inward toward the cavity of the Cylinder; and raiſing the inner Membrane into Bliſters. See Fig. 20.

In the perfectly ripe Anthera the appearance is the ſame, only that the Bliſters are innumerable, and are larger; contracted at the neck, and ready to fall looſe into the cavity of the Cylinder. This is repreſented at Fig. 21.

The globules of Farina, which hitherto we have been content to call Bliſters, are thus perfected. The ſmall portion of the Fleſh which has, by thruſting out its point, raiſed the Bliſter, grows a little more; but the force of Nature is ſo ſlight at this diſtance from the Root, that the little point of this ſmall portion of the Fleſh, tho' it continues growing, cannot pierce the Membrane formed by this Bliſter. Not being able to get thro' it turns backward, and by growing a little longer, forms that oval ring before deſcribed, which is properly the embryo of a new Plant. See Fig. 21. The waxy Veſſels having run up all the way with theſe minute portions of the Fleſh, terminate by plainly open mouths, where the portion of the Fleſh forms the Bliſter, and diſcharge their contents into that new cavity.

The extreme ends of the Veſſels of the portion of Fleſh in the globule of Farina inoſculate with themſelves, at the place where they touch, that is, at the baſe of the Bliſter; and the Membrane forming the Bliſter contracting there, and the Veſſels drying for want of more nouriſhment, the work of Nature is ſo far accompliſhed.

Thus a piece of the Fleſh of the Plant, replete with its proper Juices, and ſurrounded with a waxy fluid, is lodged in a little membranous bag, which, as ſoon as its neck grows perfectly dry, falls off from the inner ſurface of the Anthera, and is a globule of Farina. This contains in it a portion of the Fleſh, which was the eſſential ſubſtance of the Plant, and

which, tho' very minute, yet if preſerved from injuries, will be ſure to grow when it has heat and moiſture. It is defended doubly; partly by the Membrane, and partly by the waxy fluid which ſurrounds it. It is too tender for the earth, and is to be received firſt into the Seed.

THIS is the origin of a globule of Farina; which we are now to examine diſtinctly. To this purpoſe we are to take off a perfectly ripe Anthera, from its Filament, and to ſhake it carefully over a plate of glaſs, for the Double Microſcope. This ſlight motion ſeparates a multitude of the globules of Farina, a cluſter of which we are to ſelect for examination. They are all perfectly alike in ſhape; oblong, elliptic, rounded at each end, ſomewhat opake, and of a whitiſh colour, with a darker oblong particle in the middle. This is ſometimes greeniſh, ſometimes yellowiſh, and is the embryo Plant; the extreme termination of the portion of the Fleſh of the original Stalk, which raiſed that Bliſter: and it appears greeniſh or yellowiſh as more or leſs of the waxy matter covers it. On putting a drop of water to them, they ſwell, become ſhorter, rounder, and more tranſparent; and we perceive a ſmall ſtrake in the midſt of each running lengthwiſe from end to end. One of the Globules, as it appears dry, is repreſented at Fig. 22, and as it is ſeen in water at 23. The line is the place where the Globule adhered to the inſide of the Anthera, and is the part where it opens at a proper time, to let out the embryo Plant, as at 24.

IT has been ſaid all globules of Farina burſt when wetted, and diſcharge ELASTIC ATOMS: ſome burſt readily; others do not: but whenever they do burſt, what they diſcharge is this embryo Plant, encompaſſed with a waxy matter, which, not mixing with the water, appears granulated. That is all.

IT ſeems, from the experiments I have hitherto made, that thoſe Farina which have rough ſurfaces, and are large, burſt upon the head of the Style; as the Mallow kinds; and only the embryo Plant, covered with is waxy Juice, enters the Seed-Veſſel: on the contrary, that thoſe Farinæ which are ſmall, ſmooth, and of a fit ſhape to make their way entire into the Seed, are received into the Piſtil without burſting: this is the caſe univerſally with the Farina of the Radiſh, which therefore does not burſt ſo readily in water. However, as moiſture is in the end to cauſe its opening, what is to be tranſacted naturally within the Seed, may be done on the plate of glaſs. The Farina muſt be perfectly ripe for this purpoſe; a great deal of it muſt be laid upon the glaſs, and the drop of water often renewed. By this means we ſhall ſee one or other of the Globules burſt: the opening always is at the line in the center, and uſually towards one

end; and there comes out a maſs of ſoft but granulated matter, which might be ſuppoſed a cluſter of elaſtic atoms. Fig. 24. To know what it really is, another courſe is neceſſary. The drop of water muſt be ſuffered to dry away, and a drop of oil muſt be put in its place. Obſerving this from time to time, we ſee the granules, which ſeemed atoms, diſſolve into a ſmooth uniform ſubſtance, which, as it is thus rendered thin, becomes tranſparent; and we diſcover in it that annular rudiment of a new Plant very diſtinctly, which we had ſeen obſcurely in the entire globules. The lump thus melted is repreſented at 25, with the embryo in the middle of it, and at 26 the embryo alone.

THERE is no other way of examining the Farina of Plants. Reaſon dictated this; and I have been ſo happy to find it ſucceed perfectly. I ſaw their error who fancied the waxy matter of the Mallow Farina to be diſtinct hard bodies, and who extended one obſervation as a law to univerſal Nature.

I FOUND, what all will find who try, that few Farina burſt in water. It was plain, that the ſolid matter in the Farina could be no other than one ſingle piece of the parent Plant; and what was there beſide, could be only the Juices of the Vaſcular Series, ſince no other part of the Plant beſide the Fleſh and this had any communication with the Farina, or, indeed, with the body of the Filament. Many obſervations had ſhewn me, the Juice of the Vaſcular Series was waxy; indeed I am perſuaded, all the wax which bees collect has this ſource, and no other: whatever therefore would diſſolve wax, would have the ſame effect upon this Juice in its cluſtered ſtate about the embryo, and whatever diſſolved this, would ſhew that embryo: on theſe plain principles I uſed oil, which is the ſimpleſt of all the diſſolvents of wax, and the leaſt oppoſite to the vegetable nature: the effect was as expected; and this way I obtained what others may at any time obtain by the ſame means, a plain and diſtinct ſight of the embryo Plant.

THUS we ſee what the original embryo of the Plant is. We find it is a naked circular piece of Fleſh of the parent Plant, defended from decay by being covered with a ſubſtance indiſſoluble in water.

THESE Embryos, millions of which are contained in every Anthera, are to be received into the Seeds; and it will be neceſſary to examine now, by what paſſage they are to get at this; and what is the condition of that Seed before they reach it.

CHAP. XXX.

Of the CONVEYANCE of the EMBRYO into the SEED.

NATURE provides, for the reception of the Embryo, thus form'd in the Farina, a peculiar caſe, the Seed, which receives it naked, and gives the firſt means of a limited growth. In the center of the Radiſh Flower there riſes a ſlender, long, irregular cylindric body, crowned with a ſmall rough head. The cylindric body is the young Seed-Veſſel, and the rough head is the Stigma, which is rough for detaining the globules of Farina, and moiſt to make the paſſage of the Globule eaſier into the Seed-Veſſel; that being its office. See Fig. 27. It is formed of tubes with open mouths, capable to receive the globule of Farina; and theſe, after a ſhort ſtraight courſe, all open into the hollow of the Seed-Veſſel.

IF we cut open the Seed-Veſſel in this tender ſtate, and before the Seeds have received the embryo Plant, we ſhall find plain proof that they have this and no other uſe. For this purpoſe we are to chuſe a flower not yet open. In this we ſhall find the Filaments very ſhort, the Antheræ long and entire, and the rudiment of the Seed-Veſſel tender and whitiſh; if the Seeds have any young Plant in them now, it is their own, for no grain of the Farina is yet ſhed; indeed they are ſcarce formed.

WE find on cutting the young Seed-Veſſel tranſverſely, that it contains a double row of rudiments of Seeds, with a column in the middle; and a quantity of ſpungy matter among them. This is repreſented at Fig. 28. On cutting it lengthwiſe, we ſee that the column in the middle of the Seed-Veſſel is continued to the very ſummit; and that the rough head or Stigma, is only a continuation of this column without the inveſting Membranes of the Pod. See 29. The Seeds arranged on two ſides of this column, adhere to it in the very manner that the globules of Farina do to the inner ſurface of the Anthera, that is, they riſe from it: they are originally bliſters in the ſurface of the Receptacle, and they retain to the laſt their opening into it. This is repreſented at 30.

THESE Seeds in ſo young a Pod as we are now examining, are mere tranſparent Blebs or Shells, opening by an oblong mouth into the hollow of the column. In a Flower a little more advanced, we ſee this Shell filled with a thick white fluid, and in this condition we always find it, with this ſimple and uniform appearance in the young Pods of thoſe Flowers whoſe Anthera are not yet burſt. Such a Seed is repreſented at 31, filled with

with its thick Juice, but with nothing elſe in it, and with its original aperture where it adhered to, or grew from the column.

If, after repeating this obſervation on the Seeds of many Flowers in the ſame ſtate, we afterwards examine the young Pod in a Flower whoſe Antheræ have burſt, we ſee a very manifeſt difference. We find the Seeds of the ſame form, and filled with the ſame thick Juice; but we alſo ſee in each a ſmall ſolid and not tranſparent particle. See Fig. 32. This ſolid particle is of the ſame form and ſize with thoſe in the globules of the Farina. Thoſe globules have been diſcharged from the Anthera: there is a plain way, and in this Plant a very eaſy one, for them to theſe Seeds; and therefore we can have no reaſon to doubt this is the very particle that was in the Farina. The object is very minute, yet an accuſtomed hand may draw it out of the ſoft tender Seed, and obtain conviction from the Microſcope, that it is the very annular embryo of the Farina figured at 26, not yet in the leaſt altered. It is a naked ring of the Fleſh of the parent Plant. By degrees this naked embryo gets its ſeveral coverings, the thick Juice of the Seed is received into two Seed-Leaves; and the preſent growth ceaſes. A Seed in this State cut thro' tranſverſely, and a thin ſlice of it powerfully magnified repreſents the embryo Plant ſtill retaining its annular form, and only altered by a protuberance from one part, which is the firſt puſh toward the growth of the Plant. This is repreſented at Fig. 33, and the Embryo ſeparate at 34. This is the condition of the perfect Seed of the Radiſh. This Embryo is the Corculum or Heart of the Seed; and is ready to grow, on being planted.

That this Corculum of the Seed is really the Embryo originally produced in the Anthera, is evident from thoſe obſervations; and the fact never fails to be aſcertained by many caſual incidents in the courſe of the enquiry. The Globules of Farina are, in great part, ſcattered in the air, but many of them fall upon the Stigma, whoſe moiſt open Veſſels convey them, by a plain ſhort courſe, into the hollow of the column, along which, from top to bottom, are two rows of openings leading into the ſeveral Seeds. In opening the young Seed-Veſſel lengthwiſe thro' the center of the column, and the head of the Stigma, when the Antheræ have newly burſt, we ſee not only that the Tubes of the Stigma all open into the hollow of the Column; but we ſee in theſe Tubes, as well as upon the ſurface of the Stigma, many globules of the Farina, and multitudes of others which have paſſed thoſe Tubes, ſticking to the inſide of the Column. Such of the Globules as fall upon thoſe places where there are openings into the Seeds, naturally enter into them; and there, while the Juices

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yet come into the Seed-Veſſel, take their firſt growth; which forms the protuberance ſeen in the perfect Seeds, and gives the Embryo all its coats, and Seed-Leaves. This done, the Juices no more flow into the Seed-Veſſel; every thing hardens; the Seeds in time become looſe, dropping off from the Column; and the aperture by which they communicated with the inſide of the Column, contracts in the manner of a ſcar; but ſtill there is a little opening left; which glaſſes will diſcover; and out of which the Plant afterwards ſhoots.

THUS is the Seed of the Radiſh formed, including a minute embryo of a new Plant; whoſe progreſs in growth we are next to trace. This will be an eaſy taſk, the object being large enough for the naked eye to examine, and even the whole ſtructure plain to very ſmall powers of magnifying.

CHAP. XXXI.

Of the GROWTH of the PLANT from the SEED.

THE ripe and perfect Seed of a Radiſh is compoſed of four parts. 1. A brown hard Shell or Rind, a. 2. A yellowiſh pulpy ſubſtance, formed into two doubled flat plates, appearing four, b. 3. The Heart of the Seed, which is the Embryo conveyed thither from the Farina, c. And 4. A fine thin white Membrane, d, placed between the Embryo and the Shell, in that part where the Seed originally adhered to the Column while it was in the Pod: this is now continued as a covering to the Embryo to the place where it joins the two inner plates. The Seed cut aſunder tranſverſely, is repreſented at Fig. 35; the ſection being made near the place where it grew to the Column; in this we ſee diſtinctly all the parts. *a* is the brown Rind; *b* the outer folds of Plates; *c* the inner folds, ſmaller, and gathered cloſer round the Embryo; *d* is the Embryo, and *e* the fine white Membrane torn from the place where it adhered to the outer Shell.

THERE is a little hollow about the Embryo, and its ſmalleſt end ſtands toward the ſurface of the Seed, covered with this Membrane. With careful management we may ſeparate this Embryo from the Seed: we then find it a ſmall oblong body, pointed at one end, and the other ſpreading into thoſe two plates which run from it on each ſide, and terminating between them by a ſmall curled head. The entire Embryo taken out of the Shell is repreſented at 36, *a*; and opened at 36, *b*, where we find plainly

plainly that it is no other than the particle of the original Fleſh, 34, ſomewhat larger, and with a beginning of growth; the part 34, *a*, is the ſame with 36, *a*; and 34, *b*, the ſame with 36, *b*. And the whole being ſplit, and viewed in a thin ſlice by the Microſcope, ſtill ſhews itſelf to be the ſame original elliptic ring of Fleſh which was produced in the globule of Farina, 37. All the difference here is, that this Embryo is clothed with ſeveral Coats, not naked, as it was produced there: and that at the end, *b*, which is to give riſe to the aſcending Stalk, it has ſhot out two broad plates, and a ſmall convoluted head between them. Theſe two plates are to be the Seed-Leaves of the future Plant, the convoluted head is the firſt rudiment of a Stalk, and the end, a, is to extend itſelf into a Root.

THIS Embryo is what has been called the Plantula Seminalis; and people have fancied they ſaw in it the entire future Plant; not knowing that the Flowers, and other parts, were to be abſolutely produced in the ſucceeding Plant by the plain courſe of growth; but conceiving they were all here, and only to be unfolded. If we proceed to cut the Embryo taken from a perfect Seed tranſverſely, we may with powerful glaſſes ſee in it every one of the ſeven conſtituent ſubſtances of the ſucceeding Plant. They are far from diſtinct: an eye not before informed what were the conſtituent parts of a Plant, would have little chance to diſcover them; but being known in the Vegetable Philoſophy, they will be all found in their places here.

THE entire Seed of the Radiſh is of a figure approaching to oval, but irregular; the Skin is brown, and there is a black ſcar at the place where it originally grew to the column in the Pod. Againſt this part of the Seed is placed the part *a* of the Embryo, 34 and 36; and at the oppoſite end the part b, where the Embryo ſpreads into the two Plates and intermediate Crown.

THE Seed being put into the ground, receives moiſture, and its inner ſubſtance ſwells. The original Juices in the Embryo, *a b*, 36, are diluted by the fluid received from the earth, and the continual changes of the temperature of the air, in reſpect of heat, put all in motion; for every thing ſwells with heat and ſhrinks with cold; and there is no minute in the day wherein there is not ſome ſmall change in the degree of heat about us. Little changes affect little bodies; and conſequently theſe affect the moiſtened Embryo in the Seed. The Juices being made thin enough to flow, are forced along the Veſſels by this alternate contraction and dilatation of the body itſelf; and new nouriſhment being ſupplied, the Veſſels become extended, and increaſe.

ALL

ALL this is tranſacted in the body of the Seed, which is yet entire. But when the brown Coat is capable of no more diſtention, it burſts uſually at the bottom, that is, the part oppoſite the ſcar; and gives way to the ſwelling Embryo to ſpread. A Seed perfect, and fit for ſowing, is figured at 38: and at 39, one burſt, and letting out the embryo Plant.

THE brown Skin, which is now of no more uſe, may be eaſily taken off; and we then ſee the naked embryo, 40, conſiſting of a conic white part, and a rounded, but flatted body, compoſed of two doubled Plates, between which, tho' on one ſide, runs the conic part.

THIS little Cone is the original annular Embryo of the Farina, now conſiderably lengthened, but no other way altered; and covered with its Coats. The broad flakes are the matter of the body of the Seed, now formed into the rudiments of ſeminal Leaves; and tho' they had appeared to be four, we find in this advanced ſtate that they are but two. They are not ſeparate at the edge oppoſite to the little cone, but only folded for the convenience of being contained in that ſhell.

WE now find, that theſe two parts, the Cone, and the pair of Leaves, make up the whole body of the Seed; and this confirms what was before ſaid of their origin; that the original of the Embryo of the Farina plainly begins its growth in the growing Seed; that the Juices ſent thither ſerve only for its nouriſhment, and that thoſe two folded Plates, and its Crown between them, are its firſt growth; which ſtops only becauſe no more Juices are ſent thither. In ſome ſpecies the Embryo grows more, in ſome leſs, in the Seed; but that is all the difference.

AFTER the brown Shell of the Seed is fallen off, and the young Plant is looſe, the Progreſs in growth is very quick. The Cone, 40, a, lengthens, and becomes a Root; and the two folded Plates enlarge, and ſeparate at their edges, and begin to ſpread aſunder. We perceive very diſtinctly, that the back of each is entire, and we ſee one riſing above the other, as at 41. Thus that part of the Embryo which has extended itſelf downwards for a Root, acquires its proper form, and is committed naked to the earth; from which its ſpungy ſubſtance attracts nouriſhment: but the convoluted head, which is the firſt rudiment of the Stalk, is ſtill cloſe covered by theſe two Plates, and is a mere dot, making no advance toward extenſion.

ALL this is tranſacted within the earth therefore the parts have not their proper colour; theſe two folded Plates, which are preſently to become what we call ſeminal Leaves, are yet yellow. This may be called the FOURTH ſtate of the Plant.

HITHERTO

HITHERTO all the parts have kept their places, only the Cone has lengthened: but as they will be moved a little hereafter, it is now we are to aſcertain their original. We ſee the particle, 34, which I have called the Annular Embryo of the Farina, is the original Rudiment of the new Plant: it has in the Seed ſent off its two folded Plates, and has begun a little to extend the oppoſite way in length. It will be important to know at what point in the ſucceeding Plant the growth began, which has extended it ſo far each way: and this muſt be aſcertained now. It is the part marked b in Fig. 36; *c* in Fig. 40; *d* in 41. This was the center of the original annular Embryo 34, the part *d*; and this has in the ſucceeding growth to the fourth ſtate, Fig. 41, extended itſelf in length in the Root downwards, to ſeveral times its original bigneſs; and has made a very minute advance upwards, in the convoluted Head or Bud; which is hitherto almoſt imperceptible.

AFTER a little time the young Plant advances from the irregular form 41, to the proper appearance of a Seedling. As we are to count every article of growth from the place of the original annular Embryo, it will be proper to mark that every where with ſome one appropriated Figure as *. This is added to the *d* 41; and by this mark we ſhall know the ſame ſpot of origination in all the ſtates of the Plant. The firſt advance the Embryo 41 makes toward a Seedling, is by the expanding, ſeparating, and, in ſome degree, raiſing the two folded Plates, which we are now to call Seminal Leaves. This is naturally tranſacted juſt at the ſurface of the ground, or, as we may ſay, between earth and air. The Plates now ſhew their true form, being broad, ſhort, and dented at the end; and they now begin to ſhew alſo their green colour. See Fig. 42. The point of growth *, now ſwells a little, and juſt upon its ſummit, between the baſes of the two Seed-Leaves, appears the Bud.

THE growth from this ſtate is quicker than before, and the Plant increaſes very conſiderably; the perfect Seedling is repreſented at 43: and from the former courſe it will be eaſily underſtood how it has acquired this form. The part *, which in 41 was under the earth, and in the ſtate 42 had reached the ſurface, is now raiſed conſiderably above it. If the line *a* be made the ſurface of the ground, this will be underſtood perfectly. We are not to ſuppoſe the Plant has yet any Stalk. The ſeat of growth is at *; and tho' a part of the Plant is raiſed above the ground, yet we know this is the point of diſtinction between Root and Stalk: from this point * downward, is Root; and from this point upwards, is Stalk; no matter where the ſurface of the earth comes.

THE original of a Stalk is the Bud *c*, which has yet made no advance whatſoever toward riſing. Therefore in the Plant repreſented at 43, the part from * to *b* is Root; that portion between *a* and *b*, is the Root under the earth; and the part from a to *, is the Root above ground. The Bud, *c*, ſtands cloſe upon the head of the Root; and the Seed-Leaves, *d d*, having riſen on a kind of Footſtalks, the Bud, *c*, is defended very finely by the hollow baſes of thoſe Footſtalks where they lap over one another. The rudiments of theſe Footſtalks were always to be ſeen at their baſe, tho' very ſmall, and their extenſion in length is from the mere aſcent of the Sap. Theſe Seed-Leaves are now at their perfection and the next force of Nature is directed to the Bud.

THE advantages a Plant receives from the air are very conſiderable, and they are obtained by means of the Leaves; which diſcharge a great quantity of moiſture during the day, and imbibe a great deal during the night: the healthy ſtate of a Plant always depends upon this, and in moſt circumſtances its life, as we ſee by taking off the Leaves of Trees and Herbs, during the ſeaſon of their growth. The firſt Leaves of the Radiſh are theſe, and it is ſo in moſt other Plants. Till they obtain their ſtate of perfection, the Bud makes no advance toward riſing. The Juices which have been received from the earth, have ſwelled the Veſſels, expanded and enlarged the Seminal Leaves, and ſent down the Root to ſome conſiderable length; but more was needful to increaſe the Bud, a communication between the Veſſels of the Plant, and the free air; and nouriſhment received thence: theſe Leaves are now in a condition to give it; for they are perfect: therefore the Bud now begins to diſcloſe itſelf. To know how theſe two Seminal Leaves perform this important ſervice, we muſt examine their ſtructure.

CHAP. XXXII.

Of the STRUCTURE of the SEMINAL LEAVES.

WE ſee that what is called a Seed, independant of the original Embryo, is a ſhell, and nothing more; therefore it is in the progreſſive growth of that Embryo, we are to ſeek the whole fabrick of the ſucceeding Plant. It was delivered naked into the Hull of the Seed; there it got its coverings, and ſhot out from the upper end two flat and folded Plates. Their uſe we ſee now; for in the ſecond growth they are to become the Seed-Leaves.

This

This growth of the Seed when put into the ground, may juſtly be called the ſecond; for the firſt was abſolutely taken while the Seed was nouriſhed from the Plant. We have traced the growth of theſe folded Plates into abſolute Seed-Leaves, raiſed upon Foot-Stalks, and with their juſt green colour. Fig. 43. In this ſtate of the Plant, from the point *, to the extremity of the Root in the earth, is one ſimple uniform body; and this is, properly ſpeaking, all of it the Root of the Radiſh. A tranſverſe ſection of this ſhews all the ſeven conſtituent parts: we diſtinguiſh eaſily a red outer Bark, a whitiſh inner Rind, a large white Blea, a pale Vaſcular Series, a green Fleſh, ſix Conic Cluſters of Veſſels, of a deep green, and a white Pith. The Blea bears a great proportion, and the Pith is but in moderate quantity. See Fig. 44.

We ſee the Root is perfectly formed: indeed, in the Courſe of Nature, it could not be otherwiſe, for all this part, from * to the extremity downwards. 43, is no more than the original annular Embryo, 34; which has extended itſelf in length, and in ſome degree alſo in thickneſs; but without any violence to its own conſtruction. We ſee the progreſs of this growth ſuperficially in the enlargement of the little Cone or embryo Root; 35, 36, 40, 41, 42, 43. But to underſtand it perfectly, the Cone or annular Embryo muſt be ſplit lengthwiſe down the center, in all thoſe ſtates; and viewed with ſome aſſiſtance of the Microſcope. In this method we find the Cone *a b*, 36, a very ſmall advance from 34. The Cone or growing Root of the Embryo 36, is repreſented thus ſplit and magnified at Fig. 45. And we thus ſee the beginning of the increaſe of the Coats, that of the Blea growing faſteſt: there is in this a ſmall Pith. If we cut the ſame Cone tranſverſely, we ſee ſix dots, which, indeed, are viſible, with ſufficient magnifiers, originally in the Embryo itſelf, before its growth begins; and are the ſections of the ſix conic Cluſters of Veſſels.

If we again diſſect the Root at the growth 41, we ſee no other change than a gradual increaſe. This Root, which is now the eſſential part of the Plant, has grown in a degree much greater than the Leaves, and the Bud ſcarce at all: we ſtill ſee the original Embryo encreaſed in length, and covered with more diſtinguiſhable Coats, but nothing elſe: counting from the point * to the extremity, the whole is ſtill an annular body, vaſtly lengthened, for the Coats all return upon themſelves at the lower end of the Root; and the original ſubſtance or Fleſh of the Root, returns alſo upon itſelf, at the upper extremity or point *, tho' it ſends up a portion from its ſurface to the yet dormant Bud. See Fig 46.

NEXT if we ſplit lengthwiſe the Plant in the ſtate 42, cutting thro' the two Leaves and Bud, we ſee the ſame form and condition of the whole, only more grown: the Root is longer, and its Blea and Pith are in much larger quantity; but the Bud is not yet at all advanced. See a magnified ſection of this at Fig. 47. The original ring of Fleſh, which was the Embryo in the Farina, is extended in length, and covered, but nothing more: and we ſtill ſee the ſeveral parts all rounding the end of the Root, and the Fleſh, making an arch at the head of the Root, the point * from whence the Bud riſes. The Bud is little altered; but we ſee the Seed-Leaves juſt in that part, begin to riſe on Footſtalks.

LAST of all in the examination of this ſtate of the Plant, it will be proper to cut ſtrait down, in the ſame manner, the entire and perfectly grown Seedling. 43. This will ſhew us the growth and uſe of the two firſt Leaves; and the diſtinction and connections of the ſeveral parts of the Plant. A ſection of this kind is repreſented at Fig. 48. If we begin the examination at the point *, we there find the original termination of the annular Embryo ſtill preſerved entire; and as the whole Plant above the ground, is to riſe from this point, we ſee a proviſion for ſuch a work: the Fleſh extends to three or four times its uſual thickneſs in this part; and the arch is formed entire, tho' leſs vaulted than uſual in the lower ſide of it. From the upper part and outer ſurface of this ſwoln portion of the Fleſh, ariſe all that is conſpicuous in the Plant. From the outer ſurface of the Fleſh of the Root continued in this ſwelling, there is ſent up on each ſide a portion of its ſubſtance, which runs ſtrait up the center of the Footſtalk of each Seed-Leaf, 48, a. Within this are the Conic Cluſters, tho' not eaſily ſeen in the longitudinal ſection, 48, b: and over theſe two ſubſtances run up regularly the Blea, and the two Rinds.

WE may judge of the importance of the Seminal Leaves of Plants by this conſtruction. The permanent Radical Leaves of the Hellebore conſiſt only of three ſubſtances, the inner Rind, and Blea with the Conic Cluſters. But theſe, ſhort as their duration is to be, carry up alſo a part of the Fleſh of the Plant. We have ſeen that this is ſent up from the ſurface of the Fleſh of the Root; and the Veſſels of the Conic Cluſters are formed within this, in each of the Footſtalks; but the Blea and the two Rinds, *c d e*, are all ſimply continued from thoſe parts in the Root. A piece of a Footſtalk more enlarged, is ſhewn at Fig. 49. From the upper ſurface of the central part of the ſwoln Fleſh at the head of the Root, riſes the Bud for the future Plant, *f*.

THUS

THUS the Fleſh makes its regular courſe in its lengthened annular form along the Root, and only from its ſurface gives theſe parts which are to appear above the ground: the Fleſh of the Bud upwards, and that portion of Fleſh which is allotted to the Seminal Leaves ſideways.

WE are now to examine the proportions of the ſeveral parts in the Footſtalks of the Seed-Leaves by tranſverſe ſections. The flattened, hollowed form of the Footſtalk makes a tranſverſe ſection of it appear ſomewhat in the form of a Creſcent. The outer Rind, which was red in the Root, continues its colour alſo in this part, and even the Veſſels of the Blea have a red liquor. This diſtinguiſhes excellently the Veſſels of that part from the Cells which they form, and which ſome have taken for Veſſels; the fluid in thoſe cells being colourleſs, while this is red.

WE have had occaſion to remark a ſwelling of the head of the Root, at the point *; this is owing to the ſwoln ſtate of the Fleſh in that part, which forces out all the others; it is here a portion from the ſurface of the Fleſh is ſent up into the Footſtalks of the Seed-Leaves, and this at its very origination in quality of the Fleſh of the Footſtalk, divides into three regular portions: each of theſe forms an inverted arch upon the ſurface of the ſwelled part, and riſes hollow into the Footſtalk.

THUS are formed three tubes, as it were, of the Fleſh of the Plant, connected intimately with that of the Root, but whoſe hollows do not open into it. Theſe fleſhy bodies divide themſelves to a diſtance, one running up the center, and the other two near the two horns of the Creſcent: they are not ſurrounded with a Vaſcular Series as the Fleſh of the Root, and Flowering Stalks of Plants, nor have they any Pith within; but each of theſe tubes gives origin to two Conic Cluſters of Veſſels, which run up within it to the Leaf: each of the ſide ones again dividing toward the Leaf ſo as to form four. A ſection cut tranſverſely, and with due care, from the ſurface of the ſwelling at the head of the thick part of the Fleſh, ſhews this diſtinctly: ſuch a ſection is repreſented at Figure 50. The diſpoſition of the three tubes of Fleſh, and of the two Conic Cluſters of Veſſels in each tube, are repreſented at 51—a, as they appear in a very thin ſection of the Footſtalk of a Seed-Leaf, near the baſe; and in another ſection taken near the Leaf, at 51—b.

THUS the law of Nature, in the origination of the Conic Cluſters, is invariable. As there are ſix in a Fibre, and twelve in the body of a Root in Hellebore; ſo there are ſix only in the body of the young Root of Radiſh, and ten in each of the Footſtalks of Seed-Leaves, that riſe from it; and in neither caſe do the greater number above take their origin from

the ſmaller number below, but are produced anew in the parts where they are found. The courſe of theſe tubes of Fleſh is eaſily traced upwards, in the Footſtalk, to the place where it expands into a Leaf.

As the Seed-Leaf is an abſolute expanſion of the Footſtalk, and nothing more; there can be no fixed point aſſigned, where the Stalk ends, and where the Leaf begins: but if we obſerve the part *a*, in Fig. 52, as the beginning of the Leaf, we ſhall ſee readily what courſe the three tubes of Fleſh, with their cluſters of Veſſels, take. The Fig. 52, repreſents a perfect Seed-Leaf, with its Footſtalk a little enlarged. In this we ſee, even in the Footſtalk, the three fleſhy bodies: the largeſt, *b*, runs up the middle, and the two others, *c c*, uniting again toward the baſe of the Leaf, as they did at their riſe, run up the two edges. When the Stalk ſpreads into a Leaf, their courſe is not altered, the fleſhy body, *b*, keeps its rout uninterrupted up the middle of the Leaf, and becomes what we call the Middle Rib; and the two others keep alſo their courſe along the two ſides of the Leaf. There are two or three ſubordinate Ribs alſo, which riſe from the principal or middle Rib in the body of the Leaf; but theſe are altogether diſtinct: they are ſent off from the principal fleſhy Tubes; whereas the two diſtinct ſide Ribs have ſhared its origination, and roſe with it.

If we trace firſt the two ſide Fibres of the Leaf, we find them in their paſſage diveſted wholly of the coat of Fleſh which covered them in the Footſtalk: this grows thinner as it approaches the part a, Fig. 51; and at a little ſpace higher in the Leaf ceaſes entirely. We have ſeen that the whole of this body was a Tube of Fleſh with two of the Conic Cluſters of Veſſels; as the tube of Fleſh diminiſhes to nothing on entering the Leaf, we ſee in the upper part of the Leaf the Conic Cluſters freed from any covering. Theſe Cluſters are formed partly of green Veſſels, and partly of a white ſpungy matter; even theſe conſtituent parts of the Conic Cluſters ſeparate in the body of the Leaf; the two Cluſters of green Veſſels run up diſtinct at a ſmall diſtance from one another, and the white ſpungy matter is placed in a large body between them, and in ſome degree alſo ſurrounds them. The middle Rib being more compact, does not ſeparate ſo much; but uſually its two Cluſters may be ſeen very diſtinctly, and the better as their Juice is red. The courſe of theſe Veſſels is repreſented at Fig. 52.

The Seed-Leaf is compoſed of all the ſubſtances we have ſeen in its Footſtalk, except the Fleſh: and they are thus diſpoſed. The outer Bark of the Footſtalk, which is a continuation of that of the Root, forms what we

we call the upper and under Membranes of the Leaf: theſe are really one The Leaf is a ſpungy body, covered by the extended and dilated Membrane of the Footſtalk; which does not ſeparate at the extremity, but, on the contrary, is more firm and compact there than elſewhere, from the innumerable inoſculations of its Veſſels: it forms in that part a kind of flat cord ſurrounding the Leaf.

If we take off this Membrane, which may be done by due maceration, we find the Veſſels diſpoſed in the uſual way, in that part of it which covered the Footſtalk, and the Membrane entire and unperforated between them: but in that part which covers the body of the Leaf, theſe Veſſels are ſeparated to a greater diſtance; and in the plain Membrane between them, there are innumerable oval apertures. This is ſhewn in Fig. 53, which repreſents the outer Bark of the Footſtalk and Seed-Leaf entire: *a* ſhews the courſe of the Veſſels in the Footſtalk, with the Membrane entire between them; and *b*, the ſame Veſſels in the coat of the body of the Leaf, where they are more ſeparate, and have thoſe oval apertures between them. We therefore ſee, that whatſoever is the office of the Leaf, the Footſtalk does not perform any part of it in common, but ſerves only to raiſe the effective part of the body of the Leaf to a proper height in the free air.

Under this outer Bark is ſpread the inner Rind. They are diſtinguiſhed by their colour and conſiſtence: the outer Rind being very thin, and perfectly pellucid; the inner Rind ſomewhat thicker, a little cloudy, and green. This is, in the ſame manner as the other, continued from the Root thro' the Stalk to the Leaf, where it expands, and conſequently the Veſſels become more ſeparated: the Membrane between theſe Veſſels is entire on the Footſtalk, as the other; but in that part which covers the body of the Leaf, it is pierced with innumerable holes: theſe are much ſmaller than the mouths of the outer Bark, but they many times exceed them in number; and they are not oval, as thoſe, but round. This ſecond Rind of the Leaf is repreſented at Fig. 54.

These make the coverings of the Leaf; but its thick ſubſtance is form'd by the Blea: this runs between theſe double coats, and is a maſs of ſponge.

We know the ſtructure of the Blea; and in the Leaf this is the ſame as in the Stalk, only for the different diſpoſition. The Blea of all Plants is a maſs of cells, formed of Membranes, and ſupported and ſeparated by Veſſels. In the common courſe of the Blea in the Stalks, and other parts of the Plant, the cells of it run ſtrait between the coats; but in the body of

of the Leaf they turn their mouths every where, inſtead of their ſides, to the ſurface, and conſequently a perpendicular view of the ſurface of the Leaf, on either ſide, ſhews us innumerable openings, which the two Rinds but imperfectly hide. In the preſent view, theſe Rinds being removed, the mouths of the cells are more diſtinct, and the Veſſels are as viſible at their corners and diviſion.

THUS the body of the Leaf is a maſs of Blea, whoſe Veſſels and Cells do not purſue their plain courſe from the baſe to the ſummit of the Leaf, but open each way to the ſurface. See Fig. 55. It is obſervable alſo, that the Veſſels of the Blea are larger here than in the reſt of the Plant. In this Blea, as in a bed, are lodged the Conic Cluſters, running from the baſe of the Leaf toward the ſummit, in a plain courſe, ſurrounded by their peculiar ſpungy matter: this continues white; but the Juices of the Veſſels themſelves are either richly green or red.

TWO of theſe Conic cluſters of Veſſels, we have ſeen, make the body of each of the principal Ribs: they run pure up theſe, and ſeparate from the ſpungy matter which lies about them. Tho' they are large at the baſe, they diminiſh toward the other extremity; and being buried in this large quantity of Blea in the body of the Leaf, are loſt to the view; but when we have ſeparated the two coats, the Blea will not obſtruct our ſight of them by the Microſcope. When we lay before it an entire Seed-Leaf, ſtripped of its coats, we ſee theſe Veſſels run nearly, but not abſolutely, to the extremity of the Leaf. In their courſe they ſend off many ſide Fibres, which are ſo many portions of their own ſubſtance; each conſiſting of a number of Veſſels; and when arrived at the extreme end of their courſe forward, they turn their points, and keep on in a new arched bend, formed by the figure of the outline of the Leaf, till they inoſculate one with another; the middle with the ſide Ribs, and theſe again with that. The ſide Fibres purſue a like courſe, and do not come to an abſolute termination any where, but all inoſculate one with another; often in conſiderable large branches, ſometimes by ſuch as are too ſmal for the view even of the Microſcope. Fig. 55 repreſents the courſe of the Veſſels in the Blea; 56 the Veſſels ſeparate.

FROM this conſtruction of the Seed-Leaves of Plants, it is not difficult to learn their uſe. We ſee their ſeveral Coats and Blea are ſo many continued ſubſtances, with the ſame parts of the Root; and that the Fleſh, and cluſters of Veſſels, tho' they be not continued from the parts of the ſame nature in the Root, yet are derived from them, and communicate with them at the point *, where the young Stalk is to riſe. This is the important

important part of the Plant; and this is fed from two ſources; theſe Leaves as well as the Root.

THE courſe of the Vegetation of the Radiſh, to the preſent period of its growth, ſeems to be this. The Veſſels of the Root having received their due portion of nouriſhment, principally at the ſpungy ends of the Fibres, the whole ſubſtance of the Embryo has been expanded, and increaſed, ſo far as to be terminated by the two large Seminal Leaves. Thus much the Juices of the Root have been able to perform: there remains the Bud to be fed for riſing to a perfect Plant; and there is now an expanſe of ſurface for receiving nouriſhment in a due proportion for that ſervice; and an apparatus of Veſſels for the preparation and diſtribution of it. A certain quantity of Juices is received from the earth; and in the hours of early morning the whole Plant is full of it. As the day riſes, the heat evaporates a great deal of this; and tho' more is raiſed, yet is not the ſupply, perhaps, ſuited to the waſte. At evening, when the heat decreaſes, and the air is full of moiſture, theſe ſpungy ſurfaces of the Leaves imbibe that moiſture in abundance, which fills all the cells, and gives ſufficient matter, out of which the Veſſels may elaborate the proper Juices of the Plant. Whether the nouriſhment riſes from the Root, or is taken in at the Leaves, it muſt, in its courſe, paſs the point *, where is placed the rudiment of the Stalk; and the ſwelling there ſeems appropriated to detain it.

WE ſee the Membranes of the Leaves are perforated, and their inner ſubſtance is a ſpunge, whoſe open mouths anſwer to thoſe perforations. Therefore the moiſture which falls upon theſe Leaves, is eaſily received into their ſubſtance. It paſſes the outer Bark by means of the oval apertures; theſe let it into the ſpace between that and the inner Rind. The innumerable round apertures in that coat let it thro' again; and juſt under theſe are placed the open mouths of the cells of the Blea, into theſe the pure moiſture enters. Theſe cells are continued, without any valve, or other interruption, thro' the Blea of the whole; ſo that the fluid thus received into them at the Leaves, mixes at once with that of the whole body of the Plant. In the ſame manner moiſture is taken in at the Roots, whoſe ſpungy heads or extremities are formed of open cells of Blea, covered only by the two pierced Rinds.

THUS it appears that moiſture is received into the Plant; and fills thoſe cells of the Blea, which make up the greateſt part of the Vegetable ſubſtance. About the ſides of theſe cells are placed Veſſels, with openings into them, which have glandular mouths: and thus a portion of this watery

tery nouriſhment is ſecreted, and becomes in part the Juice of thoſe Veſſels. At the ſame time the Veſſels of the outer and the inner Rind having received, and ſeparated part of their Juices, deliver theſe alſo to the Veſſels of the Blea; ſo that in thoſe Veſſels is contained a fluid variouſly elaborated, and regularly mixed.

THESE Veſſels of the Blea ſend branches without number to thoſe of the Fleſh of the Plant; and from them, in the courſe upwards, a part of it is given to the Conic Cluſters; and in a contrary manner a part of that delivered from the Blea of the Leaves to the Conic Cluſters, is delivered again in its courſe downward to the Fleſh near their baſes.

IN the middle part of the young Plant is placed the ſwelling 49, *a*, from whoſe ſurface many of the Veſſels of the Leaves ariſe, and with whoſe ſubſtance they all communicate. From the center of this ſwelling riſes the Bud for the ſucceeding Stalk. It is the middle point, to which nouriſhment from both extremes is directed, and which at all hours of the day and night receives it from one or the other.

THUS the watery fluid in the cells of the Blea is continually riſing and falling, according to the degree of heat; and that rich Juice ſeparated from it in the Veſſels of the ſame part, feeds the eſſential portions of the Plant.

WE have hitherto examined the preparatory parts; we are now to trace the Bud up to a perfect Plant. It has lain dormant hitherto; but the double ſupply of nouriſhment it receives, will now ſet it to growing.

CHAP. XXXIII.

Of the FORMATION and GROWTH of the STALK.

WE have ſeen from the earlieſt ſtate of the Embryo in the Seed, to the full growth of the Seedling Plant, a ſmall Bud placed at the point *, or head of the Root: and while the other parts have taken ſo much growth, this has had but little increaſe. In the Embryo, Fig. 34, the point *b* ſhews the origin of it; and to the Fig. 94, it has made very ſmall advances. At firſt it appeared a ſmall curled Bud; as the Plant advanced it increaſed a little; and in the ſtate 42, where the Seed-Leaves want little more than their Footſtalks, it appears ſomewhat leſs compact in its texture: when the Seed-Leaves have their Footſtalks, and perform their office, it grows quickly: we ſee it in one day increaſe to three times the former bigneſs and open a little at the top. One day more enlarges it, and expands

it ſo much farther, that we may diſtinguiſh it as divided into parts; and from this time new Leaves, peculiar to the Plant, are formed daily; and it aſſumes its proper form.

To underſtand the progreſs, we muſt begin with the diſſection of the Bud in the perfect Seedling; ſooner than that it diſcloſes nothing diſtinctly; but at that period we begin to ſee its conſtruction, which becomes more evident from time to time afterwards. We ſee, in Fig. 49, the manner wherein the Bud riſes from the head of the Root; and if we cut a thin ſlice lengthwiſe from this ſection, and apply more power of magnifying, it appears as at Figure 57. The Fleſh of the Root returns in an irregular arch at *a*; at *c d* riſe the two portions of it ſideways, which run into the Footſtalks of the Leaves; and at *b*, from the very center, aſcends the little Bud. It is a hollow cone, formed of the Fleſh of the Plant, ariſing from the maſs of Fleſh *e*, and is already filled with a fair Pith in large proportion. This Pith has plainly riſen from the upper ſurface of the maſs of Fleſh within the outline of the Cone; and its early appearance in this place confirms the opinion, that wherever the Fleſh of a Plant forms a cavity, a Pith is produced to fill it.

A SECTION of the Bud, altogether ſeparated from the reſt of the Plant, is ſhewn at Fig. 58. To illuſtrate this conſtruction. In this Figure, a repreſents the Pith, over which lies the cone of Fleſh *b*. On the ſurface of this we ſee a Line, c, ſcarce diſtinguiſhable, which is the ſection of the Vaſcular Series: above this comes a large Blea, d; and on the outſide of this appear the two Rinds, f g. Thus is there lodged upon the crown of the Root, the Bud of a future Plant, which has yet only a ſhort rudiment of a Stalk, h, to ſupport it; and is cloathed, as it were, in ſo many ſhells by its ſeveral outer Membranes. This we are to trace in its growth, into an entire Plant: but we are firſt to conſider the origin of thoſe Leaves which riſe from the Root next after the Seed-Leaves themſelves, and which ſupply their office in a larger way when they are faded. Theſe are not produced together with the Bud. We may be ſure of this by the preceeding obſervation; for we ſee the Bud when the young Leaves are ſeparated from it, abſolutely naked. What is figured at 58 is the rudiment of a Stalk, and nothing more. Nor are even the two Leaves which defend it formed of any part of its ſubſtance. There are eight or ten following theſe; and if they were in ſmall upon the Bud itſelf, we ſhould, by the power of Microſcopes, diſtinguiſh them: but it is not ſo. They are produced afterwards from the ſurface of that very ſhort rudiment of a Stalk

which bears the Bud; and by tracing their firſt formation and growth, we ſhall be led to the ſyſtem of increaſe in the whole Plant.

In the abſolute ſtate of the Buding there riſe two Leaves from the ſurface of that ſhort rudiment of a Stalk; the one a little higher on it than the other. Theſe are defences of the Bud; and when in the ſtate of growth, they ſpread out from it, as in the Figures 59, 60, 61. Two others riſe within their baſes, or between them and the Bud in the ſame manner. Thus are gradually produced, and thus are enlarged, all the Radical Leaves; a conſiderable number of which are produced before the firſt riſing of the Bud toward a Stalk.

We are to examine by what means they are formed, and of what parts they are compoſed; and this will be beſt traced by the help of Glaſſes, in this very minute ſtate: tho' it may be very happily illuſtrated afterwards, by what the naked eye ſees of them at their full growth.

At the point *, which is the part where the Root terminates and the Bud riſes, the two Rinds and the Blea go off to the Seed-Leaves; yet are not the Bud or the rudiment of a Stalk on which it ſtands, deſtitute of the ſame ſubſtances; for theſe are all formed regularly and eaſily wherever there is the leaſt Fleſh of the Plant.

The origin of the Radical Leaves is like that of the Seed-Leaves, from a part of the Coats and other ſubſtances riſing obliquely outwards from the rudiment of a Stalk, at the ſame time that a portion of the ſame parts covers alſo the ſurface of that rudiment. This will be underſtood eaſily by the origination and conſtruction of one of theſe Radical Leaves, examined by the Microſcope; for, indeed, it is one and the ſame ſubſtance of each coat which covers the rudiment of the Stalk, and the Radical Leaf: that is, the whole Leaf is formed by the growth of parts from that rudiment, and its Membranes are only expanſions of the coats of that part.

The Radical Leaf, in this Plant, conſiſts of two Membranes, a Blea, and three original conic cluſters of Veſſels, which ſoon divide into more, and which riſe covered with a thin coat of the Fleſh of the Plant. Their origination is this.

As ſoon as the Seed-Leaves are expanded to the air, the vaſt quantity of moiſture they receive from thence occaſions the Root to grow, and fills the rudiment of the Stalk with nouriſhment. The firſt effort of this is on the Fleſh of that rudiment; and from one ſide of it, near the head of the Root, there riſes a little proceſs from the ſurface of the Fleſh, which points obliquely upwards: immediately a ſmaller Bliſter is formed on each ſide of the firſt; and theſe puſhing in the ſame direction, raiſe the Blea, and the two

two Rinds, above them. This is the origin of a Radical Leaf, differing ſcarce at all from that of a Radical Fibre, as has been ſhewn in the Fibres of the Hellebore. Within theſe portions of the Fleſh are produced conic cluſters of Veſſels, which after a time are diveſted of that covering, and run free, juſt as in the Seed-Leaves, to the extream parts of the Leaf.

To know the true origination of theſe, we muſt go back to the young Plant, and its Conic Cluſters. A ſection of this below the point *, ſhewed theſe to be fix: as this part, which is the Root, continues to grow, it increaſes vaſtly in thickneſs; and each of theſe cluſters ſeparates, firſt into two; in which ſtate they are twelve: thus we find them in a half-grown Radiſh. After this each divides again into two, and the Cluſters are then twenty-four: ſuch as we find them in a full-grown Radiſh-Root. The whole Cluſters are ſwelled in length; and their white Veſſels cloſely ſurround the green, and are immerſed in the Fleſh of the Root, which is alſo white, and which runs in a kind of rays, intermixed with the Blea, in the manner before mentioned in the Hellebore Flowering-Stalk; but more diſtinctly.

Thus the Root continues to the point *, where there is, in this ſtate, the ſhort rudiment of a Stalk ſupporting a Bud. In a tranſverſe ſection of this rudiment of a Stalk we ſee the parts much more diſtinctly. The Fleſh loſes its white colour and radiated form, which joined to diſguiſe it in the Root, and to confound the view: here it appears of an opake pale colour, forming a regular line within the Blea; and within it, as is the uſual courſe of Nature, are the conic cluſters of Veſſels, pointing inward into the large Pith.

These are here divided into a much larger number than in the body of the Root; they may be accounted thirty-ſix; but they are ſo eaſily capable of farther diviſion, that it is impoſſible to aſcertain any regular number. The coloured Veſſels of theſe cluſters are of a deep green; and the white Veſſels which belong to the ſame cluſters, lie behind them. Thus is formed the rudiment of the Radiſh Stalk on the head of the Root; and from this place it is in the young Plant, we are to trace the origin of the Leaves, whoſe eſſential and original part is a portion of thoſe Cluſters.

Three ſmall tubes of the Fleſh from the ſurface of that ſubſtance in this rudiment of a Stalk, we have ſeen puſh themſelves obliquely outward. The Membranes and the Blea go with them; and Veſſels from the Conic Cluſters of that part whence the proceſs roſe, ſend multitudes of thoſe ſmall hollowed Fibres, mentioned in the Hellebore, out with them. Theſe pierce the baſe of the three tubes of Fleſh, and from theſe riſe new

Conic

Conic Cluſters within them. Thus is the firſt effort made for a Radical Leaf of the Radiſh.

THE three tubes of Fleſh being ſomewhat diſtant from one another, the Membranes encloſing them aſſume a broad ſhape, and the whole becomes rounded and hollow, in conformity with the ſhape of the rudiment of the Stalk from which they roſe. The tube of Fleſh grows thinner by degrees, till ſoon the Cluſters are left alone. The middle one, which runs up the center of the Footſtalk, continues ſingle; but the two others which purſue their courſe along the two ſides, preſently divide, firſt into two, then each into four; ſo that at a ſmall height inſtead of three, we ſee five of theſe Cluſters; and a little farther nine: toward the top of the Footſtalk they begin to unite again, they become only five, and finally only three, as they ſet out, till at the very part where the body of the Leaf begins, they ſometimes divide into five again, and thus run up the middle Rib.

FROM this part they ſend off portions in the ſame manner as theſe Cluſters themſelves were firſt ſent off, which being covered with a little Blea, and incloſed between the diſtended and expanded Rinds, form what we call the ſmaller ſide Ribs of the Leaf. In all theſe portions the Cluſters are entire, tho' ſmall. They conſiſt of white and green Veſſels. The main Rib purſues its courſe ſtraight up the middle of the Leaf, till it reaches very nearly the extremity; only becoming ſmaller all the way it goes, in proportion to the number of Veſſels ſent off in form of the ſide Ribs. In the ſame manner the ſeveral ſide Ribs run obliquely toward the extremity of the Leaf, and terminate in various places near its edges. In their courſe they frequently inoſculate with one another; and from that line in which they terminate near the edges of the Leaf, there are produced ſmall and wonderfully divided Veſſels which join the Ribs again.

THE ſubſtance of the Leaf between the two Membranes is a thin bed of Blea, which opens its cells to the ſurface on each ſide of the Leaf; and the Membranes are conſtructed juſt as in the Seed-Leaves. The ſide Ribs ſend off a multitude of minute branches; and from the extremities of theſe frequently riſe the hairs of the Leaf: theſe are few in number, and appear ſo many pellucid cones, when we view them by the Microſcope.

ALL theſe parts are beſt traced in an extremely young Leaf, becauſe ſuch a one is more manageable, and more tranſparent; but they may be ſeen diſtinctly in the Radical Leaves of full growth, in the Footſtalk of which the three original cluſters of Veſſels, when a Leaf is torn off at the baſe, are ſeen like three thick green cords.

THE

THE office of theſe Radical Leaves is plainly the ſame with that which the two Seed-Leaves originally performed; to imbibe, and occaſionally to diſcharge humidity; and to give room for theſe Veſſels of the Conic Cluſters to elaborate their Juices. Theſe Juices feed the Plant; and we ſee accordingly when the Radical Leaves become more numerous, the Root quickly increaſes in bigneſs; as it ſwells, the original ſkin burſts at the point *; and falls down a part of the Root in two oblong Films.

ALL this is for the feeding of the Root; for yet the Bud increaſes ſcarce at all. Its ſhort rudiment of a Stalk becomes a little lengthened, as it ſends off theſe numerous Leaves; and they continue till the Root has acquired all its ſtrength and ſize. Then it takes the part of nouriſhment upon itſelf: hitherto it has been fed, now it begins to feed; and its Juices drawn from the earth, purſuing their courſe upwards, lengthen the Stalk, and raiſe the Bud. The Radical Leaves having performed their office, now decay; and the Bud riſes to a perfect Plant.

THE courſe of Nature in this great operation will be underſtood with eaſe, now we have ſeen it in the two leſſer efforts of raiſing the Seed, and Radical Leaves.

UPON the crown of the Root originally ſtood a perfect Bud; the ſame Bud yet exiſts, ſcarce altered, except that it is raiſed a quarter of an inch more upon a kind of Stalk. We do not ſee this Stalk till we tear away the Leaves; but it then ſhews itſelf diſtinct by its green colour. The Leaves are faded; the Root draws a vaſt quantity of nouriſhment, there is nothing to be fed by this but the Bud, with its ſhort Stalk; and this grows up therefore quickly.

AS it riſes it ſends out ſome Leaves, in the ſame manner exactly as thoſe from the original baſe, which are now dead: but this is not all. The force of the Root is more than ſufficient to this purpoſe; and at ſome ſmall height from the ground we ſee in the boſom of each Leaf a new Bud: this is the rudiment of a branch, as that at the crown of the Root was of the main Stalk: and it has all the ſeven parts continued to it from the Stalk, as the Stalk itſelf had them from the Root. Each of theſe as it riſes into a branch, will, in the ſame manner, ſend out its Leaves, and Buds in their boſoms without end. Any one of theſe Buds may be ſeparated from the Stalk, and with good care raiſed to an entire Plant; as has been long time ſince propoſed in Shrubs, by the Ratiſbon Agricola, and verified by many experiments performed, at my requeſt, by Mr. BARNES. This ſhews the propagation of Vegetables to be only a continued growth.

THE

THE manner wherein the Bud for a Branch is produced in the boſom of the Leaf, is this. At the ſame time that three ſmall proceſſes of the Fleſh have projected themſelves forward, to form the Tubes for lodging the Conic Cluſters in the body of the Leaf, a larger ſimple portion begins to riſe juſt within them. This grows ſlower, but it continues to grow; and when the Leaf has obtained its full dimenſions, this begins to riſe; juſt as the original Bud at the crown of the Root did, when the Radical Leaves were fully grown.

THE original proceſs in this is a ſingle hollow portion of the Fleſh, which raiſes the Rinds and Blea, and all the other parts with it: Conic Cluſters are formed in it, by fine Veſſels riſing from thoſe in the body of the Stalk, and piercing the Fleſh: a Pith is formed within, by the Juices from the Fleſh. And here is a compleat Vegetable Body, which needs only nouriſhment to expand, and give it growth. The Plant being now in full vigour, this is ſupplied abundantly, and the Bud riſes to a new Stalk: which, ſince it grows from the main Stem, is called a Branch: but if the Bud had been taken off, and planted ſeparate, this would have been called an entire Plant. The parts are not only the ſame, in the main Stalk and the Branch, but they have the ſame number and proportion.

THESE Branches ſend out other compleat Branches, if the nouriſhment be luxuriant; and toward the ſummits of all the primary Stalks, and all the diviſions and ſubdiviſions of the Branches equally are ſent out other proceſſes of the Fleſh, which carry alſo all the other parts off with them, and are Footſtalks of Flowers; in which the ſeveral coats and other portions terminate. The Fleſh in its extream diviſions, making the annular Embryo in the globule of Farina; which after being conveyed to the Seed, and in that ſtate committed to the ground, riſes a perfect Plant again.

CHAP. XXXIV.

Of the COURSE of the JUICES in PLANTS.

WHAT has been ſaid of the formation of the Seed, and its growth, in the Radiſh, is equally true in the general œconomy of Plants; for the Vegetable Nature is the ſame in all. We have ſeen in what manner the original Juice is lodged in the embryo Plant, and by what means its motion forms the other parts; what remains for an enquiry is its Courſe in the Plant. This leads to the ſolution of a famous Problem, Whether there

there be, or be not, a Circulation of the Juices in Plants. The analogy which obtains, in many inſtances, between Animals and Vegetables, led many to think there was a general Circulation in the one as well the other; and ſome circumſtances ſeemed to favour it. The opinion was received; tho' rather from probability than experiment or proof: and it kept its ground many years. Dr. HALES overthrew what thoſe Writers had advanced, by an accurate reſearch, and a more certain philoſophy: and at this time it is the received ſyſtem, that the Juices of Plants do not circulate; but that an evaporation, and abſorption, during the alternate changes of day and night, anſwer the purpoſe.

To determine that there is no circulation in Plants, becauſe we are able to overthrow the reaſonings on which certain Authors eſtabliſhed their opinions that there was one, is raſh: for the fact may be ſo, tho' theſe have failed in the ſupport of it. On the other hand, to queſtion facts ſo abſolute as thoſe advanced by Dr. HALES, were moſt abſurd. The queſtion has not yet been rightly ſtated: nor is it neceſſary that one of theſe two ſyſtems ſhould overthrow the other. There may be a returning courſe of the Juices in a Plant; tho' not univerſal, nor like the Circulation in Animals: and this may be ſo far from oppoſing or diſturbing the ſyſtem of Evaporation and Abſorption, that it may conſpire and coincide with it in the œconomy of the Plant. Reaſon cannot deny that this may be; and I perſuade myſelf experiments will ſhew it is. This is the ſyſtem I would propoſe to the world; and I flatter myſelf they will receive it, ſo far as evident facts, and plain experiment, ſupport it.

THERE can be no wonder that this was not found before; for by ſome ſtrange fatality the parts wherein it is tranſacted, have been in a manner unknown: the Fleſh of Plants having been very imperfectly underſtood; and thoſe conic Cluſters of Veſſels, ſo eſſential to the being of the Plant, not having been diſcovered. The uſeful method will be, to trace the Juices and their courſe, along the Veſſels of theſe parts, in Plants of various kinds, beginning with thoſe of the leaſt complex ſtructure, and advancing to the reſt by gradual ſtages.

IT is the courſe of Nature that in the Seed is lodged a piece of the Fleſh of the parent Plant; and that when this is ſown, and takes its growth, the termination of the whole is in new Seeds, in which are lodged alſo ſuch pieces of the Fleſh in the ſame manner. We are therefore to trace the continuation of this Fleſh, and conſequently the courſe of its Juices from the body of the Root, which is the firſt growth of the Seed, to the

Flower; and we ſhall find this route very ſhort and ſimple in ſome Plants, and long and complex in others: it is therefore we are to ſelect the diſtinct kinds. We ſhall begin with the Colchicum, which conſiſts only of a Root and Flower. In this therefore the courſe of the Juices is ſhorteſt and ſimpleſt of all: from this we ſhall advance to the ſame enquiry in the Winter Aconite, which has a Flower-Stem between the Root and Flower, tho' no proper Stalk; the next advance will be to the Anemone, which has a proper Stalk, with a peculiar Leaf; and from this the courſe will be eaſy to all the reſt.

CHAP. XXXV.

Of the COMMON COLCHICUM.

THE common Colchicum, in its ſtate of perfect growth, conſiſts only of two parts, the Root and Flower; the Flower being fixed on the Root, without any intermediate Stalk; and no Leaves riſing with it. See Plate X. Fig. 1.

ALL Plants we have ſeen conſiſt of the ſame conſtituent ſubſtances, Bark, Rind, Blea, Fleſh, and the like; and theſe equally have place in the minuteſt Fibres of a Root, and in the Stem. Here being no Stem, we ſhall have an eaſy opportunity to ſee what thoſe ſubſtances are, and what becomes of them. The ſyſtem of ſolid Bulbs will be alſo diſcovered in this examination; for no Plant is more truly of the ſolid bulbous kind than Colchicum.

A PLANT of this kind, taken entire out of the ground in Autumn, when it is in full Flower, appears thus. An oval, but ſomewhat irregular, bulb, lengthened into a neck at the top, and in the ſame manner lengthened on one ſide at the bottom, is the moſt conſiderable part. This is covered with a thick brown Skin, and, from two diſtinct parts, it ſends out Fibres; a large cluſter from each. One of theſe cluſters proceeds from the lengthened end, a; and the other from the oppoſite ſide of the Bulb, b, where it ſeems naturally to have terminated. From the neck at the top of the Bulb, burſts out the tube of the Flower. Superficial Writers have called it a Stalk; but it is in reality the body of the Flower itſelf, not yet divided into ſegments. At a ſmall height above the ground, it is divided into ſix of theſe, and opens into a large Flower; which has no Cup: the

the outer Films of the Bulb having ſerved that office while it was in the ground.

THIS is the whole exterior appearance of the Plant: and Gardeners think, the ſingle and ſolid Bulb alone remains always; ſending up yearly its Flower in Autumn, and ripening its Seeds under covert of the Leaves in Spring. The two cluſters of Fibres might have given them other thoughts; but to underſtand the matter truly, we muſt uncover and diſſect the Bulb.

ON opening the outer Coat, and turning it back, we find in the centre a ſolid oval Bulb, with a large proceſs on one ſide, and a ſhorter on the other: along each of which runs a cluſter of Scales, covering the Rudiment of a Flower. This is repreſented at Fig. 2. If we ſeparate the ſolid part from theſe Rudiments, and its Shell, we ſee it entire, with a crown at the head, and another at the baſe, from neither of which any thing grows. This is repreſented at Fig. 3. At 4 is the entire Plant ſplit lengthwiſe: at 5 and 6 the ſolid body of the Root cut tranſverſely. At 7, the Seed-Veſſel entire, ſurrounded with its Spring Leaves: at 8, the Seed-Veſſel alone, divided, to ſhew the arrangement of the Seeds. This gives a general view of the ſtructure of the Plant; and to theſe ſeveral parts we ſhall refer in the ſucceeding explanation.

THE moſt advantageous way to begin our examination, is, to cut the Root regularly thro' the middle; and then to continue the diviſion ſtrait thro' the center of the Flower. See Fig. 4.

A TRANSVERSE ſection ſhews the body of the Bulb a ſolid ſubſtance, irregularly oval, and marked on each ſide with a deep depreſſion, Fig. 5; in which has run up the tube of a Flower, covered with Films, Fig. 2, a a. The outer coat of the Bulb is found to be a mere thick Film, connecting theſe three parts together; and it is plain, that the two cluſters of Fibres grow from the baſes of theſe two Tubes of Flowers, a a, Fig. 2, not from any other part. Theſe fall aſunder in the divided Plant, 4, there being nothing to unite them. They are not faſtened to the Bulb in this part; only preſſed againſt it by the outer Membrane.

CLEARING away the outer Coat from the bottom of the Root, we ſee, that on one ſide the baſe of the flowering part is level with the proper body of the Bulb, Fig. 4, a: but on the other, this part being much longer, the very ſubſtance of the Bulb accompanies it in a kind of horn, Fig. 4, b. The baſe of the tube of the Flower, and the horn of the Bulb, are abſolutely united in this part; but the Fibres are fixed only to the baſe of the tube of the Flower; not to the horn of the Root.

On ſpliting the lower half of the Bulb lengthwiſe, Fig. 4, along the centers of the two flowering parts, we perceive all diſtinctly. The longer proceſs of the Root, c, is joined to the part from which the Flower roſe this ſeaſon, b: and there is another ſhorter proceſs, d, joined to the oppoſite Shoot, which is to flower the Autumn following. If we examine the longer proceſs, it is formed thus: a white firm ſubſtance, like that of the body of the Bulb, conſtitutes its lower part; and this is marked with three white lines in the center. Upon the head of this grows a larger and looſer ſubſtance, Fig. 4, e; and from the head of this riſes the Tube of the Flower. That oblong and looſe ſubſtance is properly the Receptacle of the Flower, analogous to what we ſee in the other Plants.

This is the conſtruction of the part which furniſhes the Flower of the preſent Year; and that on the oppoſite ſide of the Root, is no way different, but by being younger. The Fibres have a ſmall thin head cloſe under the Receptacle of the Flower, Fig. 4, f; and this head, with thoſe Fibres, conſtitutes the proper Root of the Colchicum: the Bulb is no Root; nor does it produce any thing. How far this may be the caſe in other ſolid Bulbs, deſerves enquiry. In the coated kinds it is quite otherwiſe; the Bulb there is a Bud: the young Plant lies in its center, and the Fibres or Coats fall off as it riſes to perfection; but here the Bulb contains no Rudiment of a Plant; nor is it a Bud, or any thing of that nature. It is a Placenta, furniſhing the real Roots with their firſt nouriſhment.

When a Seed of Colchicum is ſown, its firſt produce is the part f, Fig. 4. The ſmall head of the Fibres, to which is connected the Rudiment of the Bulb. This penetrating deeper into the earth, drags down a part of the Bulb with it, which forms the horn or proceſs, a, Fig. 3. The body of the Bulb, Fig. 3, b, keeping its place higher: and at the very baſe of the flowering part, Fig. 4, f, there is that thin original yellowiſh callous ſubſtance, which is the proper and original Root of the Plant, and furniſhes the Fibres. This thin callous part is continued up the proceſs c, Fig. 4, along the baſe of the Bulb, Fig. 4, g, where it forms the little head in the center, h, and from thence continues it courſe in the ſame thin form, to the oppoſite ſide, where the little head, a, Fig. 4, is produced: this is properly a Bud for the ſucceeding year; and it contains the Plant in miniature, which is then to flower.

This is the true condition of the Colchicum: while the Plant, Fig. 1. is about to flower, the Bud, Fig. 4, a, is formed; and when the Flower, Fig. 4, b, has ripened its Seeds, and periſhes, then the Bud, Fig. 4, a, riſes,

and flowers, and a new Bud is then formed at g, Fig. 4, the Rudiment of which is fixed on the oppoſite ſide of the Bulb.

ALL this time the original Bulb remains. It is produced by the Root; and it produces nothing: it is to the infant Plant what the Placenta is to Fœtus's in the animal kinds; a large body, of a fleſhy ſubſtance, prepared to receive and detain Juices for the nutrition of the Embryo Buds. This ſolid part of the Root, which is the true Bulb, is repreſented ſeparately from the flowering part at Fig. 3. When it is cut thro' perpendicularly, as at Fig. 4, there appear a few duſky lines, which makes it ſeem compoſed of ſo many coats; but the tranſverſe ſection, Fig. 5, ſhews theſe are only courſes of Veſſels.

THE new Buds for flowering ſtrike their firſt Roots into the very ſubſtance of this Bulb; piercing it to a third part of its thickneſs: this appears by a peculiar white part in the Bulb near the Bud, Fig. 6, a. Theſe are utterly diſtinct from thoſe Roots which the Bud forms afterwards, and thruſts into the ground: and this more diſtinctly proves, that the ſolid body of the Bulb is a Placenta, containing no Rudiment of a Plant, but affording nouriſhment to the young Buds.

ALL this is ſhewn in the divided Flowering Plant, at Fig. 4, diſtinctly. The Bulb, *i*, is placed between two Rudiments, a b; and being furrowed on its ſurface, as is ſhewn at Fig. 5, it makes a ſoft bed whereupon they lie. They are connected with it at the head, whence the Fibres ariſe, and no where elſe. The Flowering Shoot, b, has all its parts diſtinct; and is furniſhed by its proper Roots with nouriſhment: the Shoot for the next year, a, is furniſhed partly by its proper Fibres, and partly by the Roots it ſends into the body of the Bulb, as at Fig. 6, a. The third is furniſhed from the Bulb entirely.

IN the Flowering Shoot, b, there is united to the head of the Fibres, or proper Root, f, a fleſhy baſe; and from this is produced an oblong Receptacle, of a ſpungy ſubſtance; from which immediately riſes the Tube of the Flower, including in its baſe the Seed-Veſſel. The Tube runs up to a conſiderable height; and within it are carried up three leſſer Tubes, the three Styles of the Flower: all theſe are covered with many Films, which were the original defence of the Bud: the outer ones decay and fade; but the inner ones afterward grow out into Leaves, and ſerve to defend the ripening Seed-Veſſel. From the upper part of the Tube of the Flower riſe ſix Filaments; which ſhew the claſs of the Plant.

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In the Bud for the ſucceeding year, a very good eye may trace ſome Rudiment of the minute future Plant; and powerful Glaſſes ſhew it more diſtinctly: but in the third Bud ſcarce any thing is ſeen.

After a time the Seed-Veſſel enlarges; and the Receptacle growing up in length, becomes a kind of Stalk: the inner Films, which ſurrounded that and the Flower, alſo grow up into Leaves; ſee Fig. 7: and thoſe who would have at firſt ſuppoſed the Plant produced Flowers without Seeds, would in this ſtate of it imagine, that it ripened Seeds with no preceding Flowers, the time being ſo diſtant; and no appearance of the one accompanying the other.

It is a queſtion of importance, where reſides the Vegetative Soul, or Principle of Life in Plants: we have allotted it, in general, to the Fleſh of the Plant; and examples are to prove this. Where there are ſo few parts, as in this, we ſhall be moſt likely to find the certainty.

The Seat of Life here is not in the ſolid Blub; for that produces nothing: and is a mere reſervoir of nouriſhment: it is not in the Flowering Shoot, for that conſiſts of periſhable Films: nor is it in the Fibres, for they will decay, and yet the Root will grow.

It is therefore, and it can be, only in that thin yellowiſh callous head of the Root, which ſends out the Fibres from below, and from which, above, the fleſhy baſe of the Receptacle riſes.

This always lives, and remains, ſo long as there is a power of Vegetation in the Plant: this is continued under the baſe of the Placenta, which is called the Bulb; and from the other parts of this thin head are ſent up Buds, whoſe ſeveral ſubſtances terminate in young Plants; and which piercing, by peculiar Roots, the ſubſtance of the Placenta, draw their firſt nouriſhment from thence; and afterwards ſend out Fibres.

In this thin head of the Root, we may diſtinctly ſee, by the Microſcope, all the ſeven conſtituent ſubſtances of Plants, and we may ſee them alſo in the Fibres. In the upper growth, the two Rinds make the Films and Leaves; and the Blea, with all the reſt, riſe, as uſual, to the Flower.

The Principle of Life is a plain, ſimple, fleſhy ſubſtance; perfectly uniform, and covered by its proper Coats: from this riſes upward, a fleſhy baſe, leſs ſolid than the Root; but of its nature, and with all its coverings: from that a Receptacle riſes, like the firſt, but yet more ſpungy; and this forms at its top a Seed-Veſſel and Seeds; all of the continued ſubſtances; which no Stalk ſupports, nor no Bark covers. The body of a Flower riſes round it, formed of the thin Blea; and the male parts grow from this, as the Styles,

Styles, or female parts, do from the Seed-Veſſel. When the Flowering Shoot has ripened its Seeds, it decays entirely, and the baſe of the Root forms new Buds, for ſucceeding years, round about the Placenta.

ALL Authors have perceived there was ſomething wonderfully ſingular in the Root of Colchicum. DIOSCORIDES mentions the hollow all along the middle of the Bulb or Placenta, διαφυσιν μεσην, from which the Flower riſes: and TOURNEFORT expreſſes himſelf very ſingularly: he ſays the Root is double, and of two kinds; the one fleſhy, and the other fibrous, or fibrated; tho' both encloſed in one common Rind. Nor does he call it properly bulbous, but tuberous; Gemina tuberoſa, altera carnoſa altera Fibrata.

INDEED the conſtruction of this part of the Plant was never ſufficiently underſtood; nor is it truly bulbous.

IF we would gather knowledge from an obſervation of nature, we muſt firſt underſtand the objects. The candid reader will pardon, therefore, this detail; without which the courſe of the Juices, in ſo ſimple a Vegetable, could not be underſtood; and every part of which, tho' new, is certain. It is a cuſtom in this idle age, for men to doubt what themſelves have been too careleſs to diſcover: but this Plant is common, and all that is ſaid of it may be ſeen eaſily.

WHEN the Seed of Colchicum is ſown, if we take it up after a few days, we may ſee eaſily, that its Principle of Life, or Plantule, is an elliptick ring of yellowiſh Fleſh, altogether like that of the callous head of the Root of an old Plant. This Ring is compoſed of Veſſels in which there is a portion of the original Juice; and there are Valves in them, as in the Hellebore, which open only one way. When moiſture from the earth enters the Seed, the Juice in its Veſſels becomes thin: the alternate dilatation and contraction, from the effect of heat and cold, preſſing, and again relaxing the whole ſubſtance, puts that Juice in motion: there is but one way it can move, becauſe the Valves will open to give it paſſage no other: therefore it runs forward in that direction.

THE Veſſels of this portion of Fleſh are ſo many elliptick rings every one returning upon itſelf, as we have ſeen in the Plantule of the Seed of Radiſh. Therefore the eſſential Juice of the Plant is not driven along Arteries, and returned by Veins, as in an animal body; but merely goes round in the ſame Veſſel.

THE additional moiſture from the earth increaſes its quantity: it ſwells the Veſſels, and the whole Ring enlarges: ſome part of it is, by the ſame force, puſhed thro' their pores inward; and this hardening on the ſurface, forms

forms Veſſels: hence ariſe the Conic Cluſters, and afterwards the Pith. At the ſame time ſome part of their Juice is, by the ſame means, forced alſo outwards; and this, hardening upon its ſurface, forms alſo other Veſſels, which conſtitute firſt the Vaſcular Series, and then the Blea and Barks.

WHILE theſe parts are all very thin, and before they are well viſible, Tubercles riſe on the ſurface of the original Ring, which is now become the Fleſh of the head of the Root; and theſe extend themſelves by degrees to Fibres; and upwards, under the covert of ſeveral Films made of the continuations of the two Rinds, riſes the Receptacle of the future Flower. This Receptacle is formed of the ſpungy parts of the Conic Cluſters, and is covered with a light coat of Fleſh: not that the whole Fleſh riſes in that form; 'tis only a part of its ſurface; and from and thro' this Receptacle are continued the ſeveral parts of the Flower.

IN all this the courſe of Nature is the ſame as in the Hellebore, only that in that Plant the Receptacle of the Flower is placed upon a Stalk; and in this it riſes from the immediate head of the Root. A piece of the head of the Root magnified, with the Fibres and Receptacle riſing from it, is repreſented at Fig. 9. And as the conſtruction here is ſo extremely plain, the whole will be underſtood eaſily.

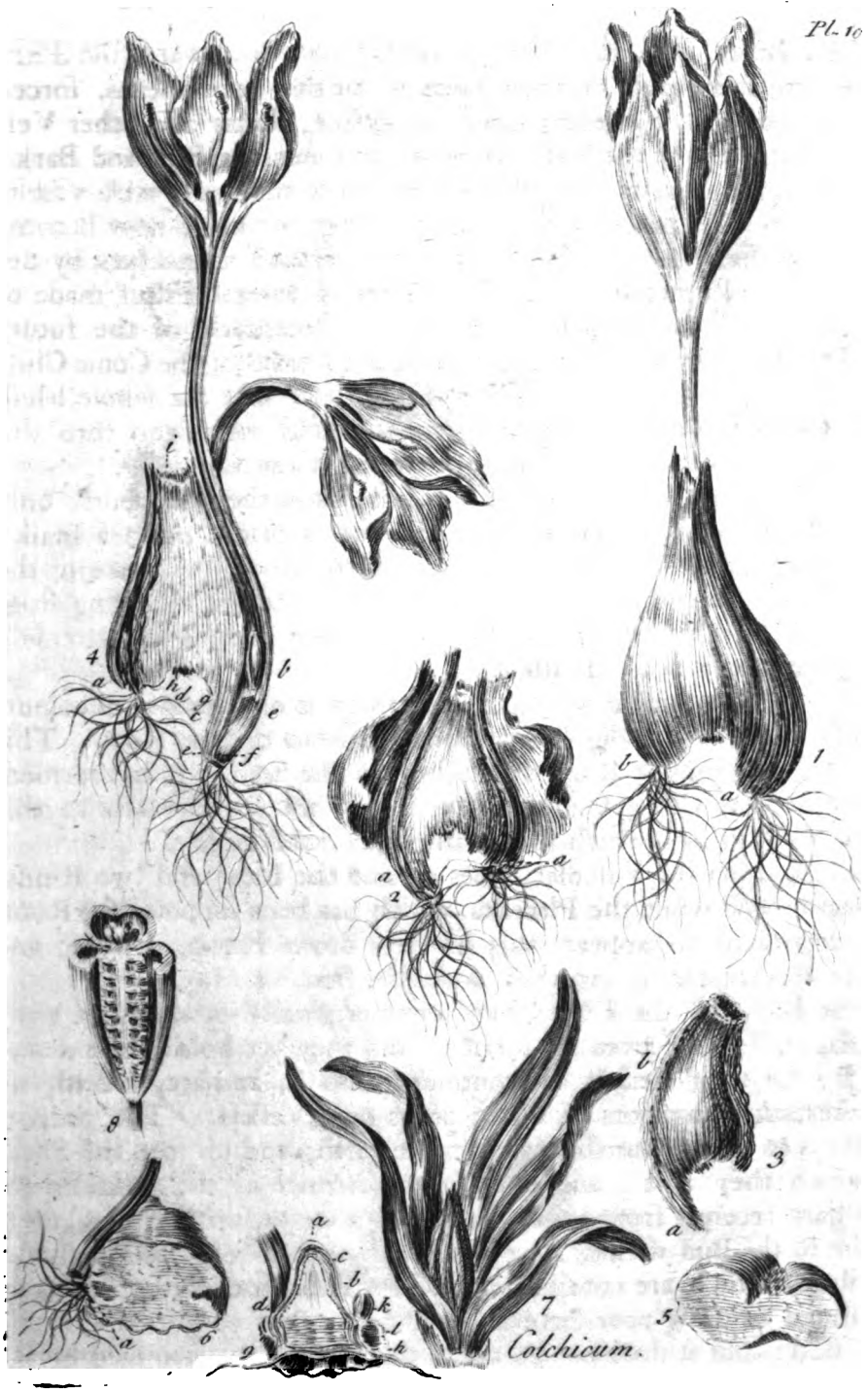
IN this Figure, the circle or ellipſis, *a*, which is of a yellowiſh colour, repreſents the Fleſh or callous ſubſtance in the head of the Root. This was originally the elliptick Ring or Placenta in the Seed. It has formed, by extravaſation, the Conic Cluſters, *b b*; which are ſcarce viſible in this ſection, and the Pith, *c*, which makes the inner Subſtance.

IT has alſo formed the Vaſcular Series *d*; and the Blea, and two Rinds, *e f g*, outward: and while the Placenta, which has been ſuppoſed the Root, is but yet beginning to appear, this has ſent down Fibres, *b b b b*, and upwards the Receptacle, *i*, crowned with the Bud, *k*.

BOTH the Bud and the Fibres have been originally produced of parts of the Fleſh, *a*, ſent off from its ſurface; and they yet hold communication with it; for their Veſſels are continued into it, and are, indeed, no other than certain elongations of a part of its own Veſſels. The purpoſe of the Fibres is to draw nouriſhment from the earth, and to feed the Shell, *a*, from which they ariſe: and from the abundance of the nouriſhment which this part receives from them, it riſes in a larger form at the Crown, giving origin to the Bud with its Receptacle, and cloſe to it to the Placenta, *l*.

THE Fibres, which are continuations of the Fleſh and its coverings, are perfectly ſuited to draw nouriſhment; and from this nouriſhment is fed the riſing Bud: but it does not go crude thither: it is elaborated in the

ſhell



Colchicum.

ſhell of Fleſh, *a*; and from other Veſſels, not from thoſe by which it was received, is conveyed to the Bud.

THUS the ſhell a, which is the Fleſh of the Plant, as it was the original of all, continues the only ſource of all; and while there is a motion of aſcent, evaporation, abſorption, and deſcent, in the whole Plant thus formed, there is alſo a circulation of Juice in the ſhell or coat of Fleſh *a*, which gives the great force of aſcent for evaporation of the uſeleſs fluid; and all the time elaborates the Juices for nouriſhment. In the Coat, a, which is the Fleſh of the Plant, there is a ſyſtem of circulatory Veſſels, which perform their office all the time that the abſorption and evaporation are continued; and theſe Veſſels, whoſe Juices purſue their own courſe, are fed by the Fibres, and feed the Bud, tho' with an improved nouriſhment. This is therefore, a kind of middle portion between the parts for drawing nouriſhment, and thoſe for growth, preparing the Juices for the one, which it receives from the other.

THE Juices which the Fibres receive from the earth are watery; but thoſe in the Body of the Plant are coloured, ſcented, and of peculiar taſte: they receive this change in the Shell, *a*, which is the Fleſh of the Plant; and this is its great office.

LET it not be objected here, that Fibres of Root alſo have taſte: they do not receive Juices thus endued with taſtes from the earth; theſe Fibres have their Fleſh, and Conic Cluſters, as well as the body of the Root, as we have ſhewn in Hellebore; thoſe parts are continuations of the Fleſh of the body of the Root, and have Veſſels connected with its Veſſels; it is in theſe parts the taſte, the ſmell, and other qualities, reſide: and as they are in thoſe Juices which have paſſed the circulatory ſyſtem in the Shell, *a*, theſe parts muſt have the ſame taſte, flavour, and other qualities with the Bud, *i*, or other aſcending parts; for they are in the ſame manner connected with the Shell, *a*, and poſſeſs its qualities. It is in that Shell the taſte, and ſmell, and colour, and virtues of the Plant, originally lie: for in the Veſſels of that Shell was lodged the portion of Juice of the parent Plant: this gives its tincture to the reſt that is received: and thus all the parts which ariſe from that Shell, have the qualities of the parent Plant, the Fibres not excepted. This is as ſure to be the caſe as if they were portions of the parent Plant itſelf; for there is no other way in which that Plant gave taſte and ſmell to all its parts.

WE have ſeen in the Hellebore what is the compoſition of a Fibre of a Root; and thoſe of all other Plants are of the ſame ſtructure. The courſe of the nouriſhment they draw is ſo ſhort in this Plant, and the

parts thro' which it paſſes are ſo few, that we may with little difficulty trace it; and yet as there are all the proper parts of the vegetable fabrick, we ſhall, by ſuch an examination, ſee the whole ſyſtem of the nouriſhment of Plants.

A QUANTITY of moiſture is to be received from the earth and air, from the nouriſhment of the Plant; and of this ſuch a Part as is fit for that nouriſhment, is to be ſeparated from the reſt, and conveyed to the ſeveral parts which are to grow: the reſt is to be diſcharged. This is the intent of Nature: we have ſeen the organs by which it is to be performed; and we are here to trace the manner.

THE Fibres have Fleſh, with Conic Cluſters, and a Vaſcular Series ariſing from the ſame parts in the body of the Root; but they have alſo a Blea, and two Barks; which tho' they have like the reſt ariſen firſt from the Fleſh of the body of the Root, yet do not return into it again, as thoſe juſt named, but purſue their plain courſe over it, from one extremity of the Plant to the other. This is the diſtinction of thoſe ſeparate arrangements of parts; and the courſe of their Juices appears to be this.

THE outer Bark of the Root runs down the Fibres, and up to the crown of the Bud, where it terminates in a kind of Films. This Bark, while the Fibres are ſurrounded with the moiſture of the earth, receives that moiſture thro' its ſpungy ſurface, and into all its Veſſels. Theſe are ſo many extremely minute tubes, up which the fluid aſcends by the attraction of their ſides; and in this aſcent it is greatly aſſiſted by that compreſſion and dilatation which ariſes from the continual change of temperature in the air. The courſe of theſe Veſſels is over the body of the Root, and up to the ſummit of thoſe Films wherein this outer Bark terminates. They are ſpungy here as elſewhere, and the Juices they contain can eaſily paſs in part thro' their ſurface.

DURING the warm hours of the day there is a conſtant evaporation of part of this Juice of the outer Bark from the Films; and by this means the Veſſels are often emptied, faſter than they can be ſupplied by the Fibres. On the other hand, when the heat of the day is over, and this evaporation ceaſes, a new operation obtains in the ſame parts: the air grows damp, and the ſpungy ſurfaces of thoſe Veſſels which are expoſed to it, can as eaſily imbibe as they could before perſpire: therefore a great quantity of moiſture is, during theſe hours of the night, taken in at the ſurfaces above ground, and makes its way, in ſome meaſure, down the Veſſels.

THIS ſeems to be all the abſolute motion of the Juices in the Veſſels of the Bark; and if ſo, it has been very idly ſuppoſed to be circulatory: yet

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as there is reciprocal riſe and fall, it may affect all the changes in the Plant, which the favourers of a Circulation have ſuppoſed to be proofs of that motion. This the philoſophy of Dr. HALES eſtabliſhed, and all experiments prove it. But there is ſomething more.

THE inner ſurface of the Veſſels of the Bark is covered with Glands: theſe ſecrete a ſomewhat richer part from the common watery Juice, during theſe its motions: and they diſcharge it, thro' apertures in the Membrane, into that ſmall cavity which there is between the outer and inner Rinds. Thus while a great deal is received, and again evaporated, ſome part is ſeparated and detained. To know what becomes of this, we muſt recollect the ſtructure of the inner Rind of Plants.

THIS inner Rind of the Fibres of Roots abſorbs alſo from the earth; for the outer Bark is too thin and too ſpungy to prevent the paſſage of the moiſture. The Veſſels of this inner Rind open by many mouths into the ſpace between it and the outer, and there receive that part of the Juice of the Veſſels in the outer Bark, which had been ſecreted and diſcharged thro' their Glands. The nouriſhment therefore received by the Veſſels of the inner Rind from the earth and air, becomes enriched by this ſecretion; and in the ſame manner its Glands, after a ſecond elaboration, deliver it to the Veſſels of the Blea.

THE Blea is compoſed of Cells, which receive moiſture from the earth and air, as do the Veſſels of the two Rinds; and from this alſo a part is concocted by the Glands of thoſe Veſſels, and received into them. The Blea aſcends to the ſurface of the earth, terminating in a kind of ſhell over the Bud, as the inner Rind terminates in Rudiments of ſucceeding Leaves. Both theſe parts go over the thin body of the Root; and in the Veſſels of both there is the ſame aſcending motion of the Juices in the day, and deſcent at night: but there appears in the conſtruction of the Blea a manifeſt and eſſential difference from theirs.

THE watery nouriſhment, and this ſecreted richer fluid, flow together in the Veſſels of the inner Rind; but in the Blea it is otherwiſe. The cells of the Blea hold the watery Juice; and its Veſſels contain only this ſecreted fluid, which is, by theſe various operations, become high coloured, thick, and of ſome taſte and ſmell.

THIS rich Juice from the Veſſels of the Blea is diſcharged thro' Veſſels, which pierce the Membrane of the Vaſcular Series, into the Shell, a, which is the Fleſh of the Plant: nor does that part of the Plant receive nouriſhment any other way.

THUS, after three concoctions, a nutritious Juice is delivered to the Fleſh of the Plant: this Fleſh is compoſed of Veſſels in which there is a circulatory motion; extremely ſimple indeed, yet capable of producing great effects. Here this additional Juice is mixed with the original Juice of the parent Plant, and goes this ſhort round many times with it. It feeds and increaſes the Pith, and the conic cluſters of Veſſels, by what it ſends into them; and the remainder being perfectly aſſimilated and blended with the proper Juice of the Fleſh, becomes one ſubſtance with it; and by increaſing its quantity, gives it new force for growth.

THIS force is directed to the points m m, in the preſent inſtance; and there a part of the ſurface of the fleſhy ſubſtance of the Root riſes, and forms the origin of the Bud. The Coats are continued over it, as in the Hellebore; and the two Rinds terminating at the ſurface of the ground, in Films and Rudiments of Leaves, which are long after to appear, the Blea is forced up higher, by the aſcending Fleſh of the Bud; and the whole riſes together into the Tube of the Flower, *b*, Fig. 4; at whoſe ſummit, juſt where it divides into Petals, the Fleſh ſeparates and burſts in Filaments, whoſe termination is in the Antheræ; and in every globule of Farina contained in thoſe, there is the elliptick Ring, which is the abſolute termination of the Fleſh in that part.

WHILE this is tranſacting in the upper part of the Flower, the Pith of the Receptacle riſes into the form of a Seed-Veſſel, and gets its needful Coats. The baſe of the Flower, and the numerous Films, defend it from all injuries: And thus, in a long courſe of time, it ripens, under the earth, thoſe Seeds, into each of which a perfect globule of the Farina has penetrated, thro' one or other of the three Styles of the Flower. This paſſage is long, but it is not difficult. The heads of the Styles are placed below the Antheræ, and conveniently for receiving the Farina as it falls: they have conſiderable hollows, always moiſt; and the globule of Farina is ſmooth and ſmall: the paſſage is perpendicular down, and therefore it makes its way more eaſily. When it has got into the Seed, all is concluded, and the growth follows as plainly and naturally as in the Seed of the Radiſh, tho' much more ſlowly.

WHILE this eſſential buſineſs is tranſacting in the flowering Plant, Nature, tho' ſlow is not idle with regard to the future Seeds. They, and the Veſſel which contains them, are to be nouriſhed as well as the Flower, tho' at a different period of time, and their ſupplies are now provided.

WITH the embryo Bud for flowering there roſe at the firſt ſhooting of the Seed a ſingle graſſy Seed-Leaf, which receiving ſome proceſſes from the

the conic cluſters of Veſſels in the head of the Root, and being formed within, as the Seed-Leaves of the Radiſh, ſerves to keep up a return of Juices and to abſorb moiſture from the air; and thus to aſſiſt in feeding the Plant. This fades as ſoon as the Bud is well formed; and then begins a new growth, for the aſſiſtance of the Seeds: the great Placenta, the firſt rudiments of which appeared early in the Seedling Plant, now grows faſter; and the Films in which the inner Rind of the Root terminated, begin to grow in length, and to looſen themſelves from the head. Theſe, however, make but ſlight advances during the appearance of the Flower, which does not want their aſſiſtance; but when it has faded, they ſhoot faſter; and when the Seed-Veſſel begins to ſwell, they pierce the ſurface of the ground, and make ſo many Leaves. This is the ſtate of the Plant repreſented at Fig. 7.

THE conſtruction of Leaves has been ſhewn in the preceding Chapters, in the Seed-Leaves of the Radiſh. All Leaves have the ſame general formation, and the ſame uſe. The diſpoſition of thoſe Conic Cluſters which make what we call the Ribs, conſtitutes all the difference: They have Veſſels which go and return, as thoſe in the Fleſh of the Plant from which they proceed, and with which they communicate; and they are formed principally of a Blea with open cells, which diſcharge and abſorb, occaſionally, the moiſture of the earth and air. Theſe Leaves are raiſed for the defence and nouriſhment of the Seed-Veſſel: they therefore do not appear till that riſes above the ground; and having ſerved its purpoſes, they fade. The Seeds are then ripened, and are fit for a new produce; but as many of them muſt fail in the uncertain way wherein Nature ſows them, the Root remains to ſupply the deficience.

CHAP. XXXVI.

The COURSE of the JUICES in the WINTER ACONITE.

THE Plant commonly known by this name, WINTER ACONITE, is properly of the Hellebore kind: Its ſingular Nectaria, its want of a Cup, and its Seed Veſſels, ſhew this evidently; but while the diſtinctive characters of Plants were leſs regarded, the fancy of Writers gave it this name; which cuſtom ſtill preſerves. It makes a natural advance from the Cholchicum, in the Vegetable Compoſition; being ſomewhat more complex than that; yet leſs ſo, by many degrees, than the generality of Plants.

WE

We have traced the courſe of Juices in a Plant wherein they made a very ſhort circuit, having only the head of the Root, the Bud for flowering, and the Fibres, for their ſphere of motion, during the flowering ſtate: In this Plant the Flower has its Stalk, and there are diſtinct Leaves upon their Footſtalks; as well as a large Leaf immediately under each Flower: therefore here is a larger circuit for Circulation, and more compaſs for obſervations and experiments. There is alſo the advantage of larger parts, in which every thing is more conſpicuous.

With this Plant before us, we may form ſome idea of the extream ſimplicity of the other. It will appear, by the obſervations we ſhall have opportunity to make, on the Anemone, and the more complex Plants, that beſide, and beyond the ſyſtems of Circulation, there are continued certain growths of the Plant, in which the reciprocal actions of evaporation and abſorption alone take place: and, in ſome degree, the ſame thing is, indeed, the caſe even in that ſpecies; tho' the whole ſcene of action in this reſpect, is there confined to the Flower. The ſyſtem of circulatory Juices there, is carried no farther than from the Receptacle of the Flower to the Fibres: the whole Flower being fed from that ſyſtem, and ſerving as the Leaves, and upper growth of other Plants, to perſpire in the day, and, in ſome degree, to abſorb in the night, the watery Juices. This, therefore, was what we called the firſt and ſimpleſt courſe of the Juices in a vegetable body: in the Aconite we find a ſecond: for tho' there is but one ſyſtem of Circulation in the Fleſh Veſſels in this Plant, which is carried on in the body of the Root, and which feeds all the reſt of the Herb; yet there is a partial return of Juices to this abſolute ſyſtem, by means of thoſe Veſſels which run into the Leaves; and which, as in all other Plants, return again into the Fleſh of the Root from which they riſe.

This may explain the purpoſe wherewith the Winter Aconite was choſen for this place: but to underſtand all the particulars, we muſt firſt entertain a diſtinct notion of the conſtruction and ſeveral parts of the Plant.

The Winter Aconite conſiſts of five parts, 1. a Root; 2. Radical Leaves; 3. a Stalk; 4. a Leaf, which has ſerved as a Cup to the Flower Bud; and 5. the Flower.

The Anemone, of which we ſhall treat hereafter, has originally ſuch a Leaf, ſerving as a Cup: but when flowering it riſes by a new Stalk from that Cup-Leaf; the Flower of this, on the other hand, remains always cloſe upon its boſom. The entire Plant, in Flower, is repreſented at Plate XI. Fig. 1.

The

THE Root, Fig. 1, a, is brown, oval, tuberous, and lies nearly horizontally in the ground; ſending long, pale brown Fibres every way upward, downward, and on each ſide. On ſpliting this lengthwiſe, together with the Stalk, as at Fig. 2, there appears to the unaſſiſted eye a white ſolid maſs, a, with a yellowiſh circle, b, in it; and covered with a brown Rind, c, from the head or crown of which riſes a Stalk, d, among ſome Films, e. The Microſcope diſcovers in this all the eſſential and conſtituent parts of a Plant, ranged in the following order. 1. A very thin, brown outer Bark, which is a mere Film. 2. A pale inner Rind, three times as thick as the former. 3. A white Blea, of a ſpungy texture. 4. A Vaſcular Series. 5. a Fleſhy Subſtance, moderately thick, and of a pale hue, with a tinge of yellowiſh. 6. The Conic Cluſters, ſmall, and greeniſh. And 7. within theſe the Pith.

THE part of the Root next the crown ſhews theſe ſeveral ſubſtances moſt diſtinctly: they gradually blend with one another toward the baſe; and only a powerful Microſcope ſhews them. In a ſlice cut ſo thin as to be tranſparent, the outer Bark is thus ſeen to be vaſcular; the inner Rind abſolutely ſpungy, from the number and largeneſs of its Veſſels; the Blea is cellular, but the cells are ſmall; the Vaſcular Series is conſiderably thick; the Fleſhy Subſtance contains fewer Veſſels, but thoſe plain, large, and diſtinct; and from the ſides of theſe ſhoot branches, which run into the other parts: the Conic Cluſters are ſmall, and nearly oval: and the Pith is an abſolute ſponge; it is compoſed of Veſſels, in whoſe cavities we ſee a thick fluid, joined like beads in a necklace; and of a great deal of looſe white matter between them.

FROM various parts of the Root ariſe Buds, which, by degrees, grow to a ſufficient bigneſs for parting from it; and forming new Plants. Theſe all riſe from the Fleſhy Subſtance; and raiſe with them all the other coats: but they have no connection with the Pith. They are ſent off from the outer ſurface only of the Fleſhy Subſtance; and they ſoon ſhoot inwards a Pith of their own. They take coverings alſo from the three Coats they carry with them, and each Offset has a Rudiment of a Plant in its Crown, covered by ſcaly ſubſtances, formed of the ends of the ſeveral Coats.

THE Fibres of the Root have the ſame origin with theſe Buds: they ariſe plainly and ſolely from the exterior ſurface of the Fleſhy Subſtance, which ſends out a part of its thickneſs into them; the main body of it purſuing its own courſe, round the Root; and theſe Fibres alſo ſoon ſhoot inward a Pith of their own; and taking with them Coats from the three outer

outer ſubſtances, they become continuations of the body of the Root itſelf, except in regard to the Pith; each forming a Pith of its own.

THIS is the conſtruction of the Root; and in this it is eaſy to ſee that the Fleſhy Subſtance is the eſſential part; the Seat of Vegetative Life, and ſource of all the reſt: if we begin to trace it at the very crown of the Root, Fig. 2, f f, we ſee it form a thick yellowiſh line, which lies under three coverings; and purſues its courſe to the very farther end of the Root, g g: it does not terminate or break off there, as has been ſuppoſed by former Writers, but purſues an uninterrupted courſe round that end, and returns up to the Crown, f f, again: it increaſes in thickneſs as it riſes toward the Crown; juſt as it decreaſed going the other way from thence.

THE reaſon of this is plain: it is entire at the Crown; but in its courſe toward the baſe of the Root, it ſends off Veſſels to the other Coats; and Pith, and the Fibres alſo for drawing nouriſhment. Theſe being a part of its ſubſtance, reduce all the way its thickneſs, till at the baſe, g g, it is a mere line, yet perfectly diſtinct. This has not been heretofore obſerved; but a great deal depends upon it.

THE Seed of the Plant firſt forms this Root: its Heart, or Plantule, as people have idly called it, is an original annular piece of the Fleſhy Subſtance, from the Stalk of the parent Plant: this ſwelling with the moiſture, and growing from the warmth, in the boſom of the earth, firſt extends itſelf in bigneſs, ſhooting a Pith within, and Coats without, for its defence; and while this is doing, Fibres, h h, are alſo ſent out to ſeek diſtant nouriſhment; and Radical Leaves, i i, to aſſiſt the courſe of the Juices. The origin of the Fibres we have ſeen: and theſe compleat what is called the Root. The riſe of the Radical Leaves, the ſecond part of the Plant, we are now to examine.

WE have ſeen, in other inſtances, the outer Coat of the Root continued up in form of the outer Bark of the Stalk; but here it is otherwiſe. In the generality of Plants the Stalk conſiſts, like the Root, of ſeven parts or ſubſtances: but in this the entire Stalk is compoſed only of ſix. It riſes from within the crown of the Root; and no outer Rind is continued to it.

THE Footſtalks of the Radical Leaves, i i, have the ſame ſtructure with this Stem: and they are thus formed.

THE outer Bark of the Root terminates abſolutely at the Crown, f f. As mere a Film as this ſeems, powerful Glaſſes ſhew it to be Vaſcular, as in other Plants; and it has two Membranes, containing the Veſſels. We ſee this in its termination in the part juſt named. Its office is to cover the Root only; and that being performed, it ſplits into a kind of ſcales, *e e*,

at

at the Crown. The outermoſt of theſe two Films which cover its Veſſels, and which is dark and rugged, breaks irregularly at that part, and the ends of abrupt Veſſels are ſeen a little beyond. The inner Film is paler, and it is carried ſomething farther: it ſplits like the firſt into irregular flakes; the principal of which make a kind of ſcabbard for the embryo Leaf.

This riſes from a ſmall point on the ſurface of the Fleſhy Subſtance of the Root; which puſhing outward, at length forms a Rudiment of a regular Leaf, faint and yellow in colour; which ſhooting above the ground, is covered at its baſe by this ſcabbard.

Its Stalk is formed of the Blea, or third ſubſtance of the Root, covered with the inner Rind; ſo that it has two Coats; the outer one very thin, and green; the inner thicker, and whitiſh. The Fleſhy Subſtance of the Root purſues its courſe entire under the baſe of this Footſtalk; but it ſends up into it a ſmall tubular portion, as in the Seed-Leaves of the Radiſh; which dividing into ſix parts, covers ſo many Conic Cluſters of large and firm Veſſels, of the ſame yellowiſh green colour. Theſe are carried up at diſtances within the hollow of the Footſtalk; and that hollow is then filled up between them by a kind of Pith: this is not continued from the Pith of the Root, for the courſe of the Fleſhy Subſtance cuts off all poſſible communication of that kind; but is formed originally from this Fleſhy Subſtance at the baſe, as the Pith of the Root was; being truly the white part of theſe Cluſters of Veſſels. The firſt Pith is formed of ſmall Veſſels, ſhot inwards from the Fleſhy Subſtance of the Root; and this of the Leaf-Stem is formed of the ſame kind of Veſſels which the ſame ſubſtance ſends, outward and upward, in that part where it is diveſted of its Blea, and Bark, by the Shoot of this hollow Footſtalk, which is formed of them, and ſo far taken their place. Where they cover this Fleſhy Subſtance, they have been formed from it, by extravaſated Juices; and in the ſame manner where a tubular Footſtalk of a Leaf is formed, this Pith riſes upwards within it, making a kind of ſoft bed for the ſix great cluſters of Veſſels. It is ſent up in the ſame manner as ſap will riſe from the ſtump of a Birch-tree up the noſe of a tin funnel, till it fills the whole hollow; altho' the funnel be raiſed perpendicularly upon it. Theſe Veſſels of the Pith are nothing more than ſmall ſtreams of the Juice, whoſe ſurface has hardened: they ariſe cylindrical; but their ſides ſqueezing one another, they become in the end ſomewhat hexagonal.

Thus the Fleſhy Subſtance of the Root is alſo the eſſential part of the Footſtalk: for the ſix cluſters of Veſſels are formed within, and covered

by a tube of that eſſential part; the reſt is only their ſupport or covering. A view of theſe ſix Cluſters, as they appear in a thin tranſverſe ſection of the Leaf-Stalk, is ſhewn Figure 3.

THESE ſix Cluſters of Veſſels run ſtrait up to the baſe of the Leaf, where they make a ſmall Gland; and thence are carried along the principal diviſions, in form of Ribs; ſending other ſmall branches from them, which again return into them. The body of the Leaf is compoſed of the entire Stalk, expanded into that form. The Membranes which cover it make the upper and lower Skin, and the white part of the Vaſcular Cluſters ſeparated from the reſt, ſupports the Veſſels along the middle.

WE ſee, therefore, that this Leaf is no more than a production in length of certain parts of the Root; and may be conſidered as one entire Gland, ſerving for the ſecretion and preparation of a certain Juice, needful afterwards for the furniſhing the Flower, and for the evaporation, and abſorption of moiſture. Its communication with the Root is open, and evident; and this is its plain uſe. The Leaves of many Perennial Plants, while young, anſwer the ſame purpoſe; and there are two ſeaſons wherein they grow and decay again, while the Flower is yet in the Bud, at the crown of the ſame Root. This is very evident in the Seedling Anemonies and Ranunculuſes.

WE come next to examine the third part of this Plant; the Flowering Stalk, Fig. 1, b. This differs little in external appearance from the Leaf, and its Footſtalk; only upon its center reſts a Flower. This Flower-Stem riſes from the crown of the Root, by a narrow neck. The outer coat of the Root is thrown off entirely at the Crown, making a ſcaly Bud, and a kind of ſcabbard for this Stalk, at its riſing: but all the other ſubſtances, the Fleſh in part and the reſt entirely, are continued to it, except the Pith.

LET the curious, who follow theſe experiments, make careful ſections of the Plant: for the ſame body, cut in various directions, affords different appearances; and the ſliping of a knife might accuſe this account of error. Let the Stalk be cut thro' tranſverſely, and ſplit perpendicularly near the crown of the Root, and things will be ſeen as at Fig. 4, and at the Letter *d* in Fig. 2. The inner Rind of the Root makes the outer covering of this Stalk; but it is in this part reduced to an extream thinneſs. Within this appears the Blea; which is white, vaſcular, and ſomewhat thicker. Within this lies the Vaſcular Series, then the Fleſh, and within that the Conic Cluſters; then, in the midſt, the Pith, riſing from the Fleſhy Subſtance in the crown of the Root, and forming a delicate and ſpungy lining.

ing. It does not fill the Stalk, for there is a large hollow in the center; acroſs which ſtretch ſome few ſtraggling Fibres.

From the ſurface of the Fleſhy Subſtance of the Root, within the circle made by the baſe of the Stalk, riſe up, as in the Leaf-Stalk, the Conic Cluſters of Veſſels: they are very large, and conſpicuous: there were ſix of theſe in the Leaf-Stalk; but in this Stem of the Flower they are twelve. Each is compoſed of a great number of Veſſels, ſome white, and others yellowiſh; containing alſo a yellowiſh thick fluid. Nature has more to do in this Stem than the other; for a Flower as well as a Leaf are to ariſe from it.

As the Stalk advances higher, the hollow in the center becomes leſs; but theſe Veſſels diminiſh very little, and they preſerve their diſtinct number, only as that grows ſmaller they come cloſe together.

At the head of the Stalk, where it is not one fourth the bigneſs that it has at the baſe, theſe twelve Veſſels crowd upon one another; for their diminution in diameter being very little, and that of the Stalk conſiderably great, they are here preſſed ſo near, that they touch. See Fig. 5. Juſt below the origination of the Leaf is the ſmalleſt part of the whole Flowering Stalk, and there theſe cluſters of Veſſels are not only preſſed much cloſer, but they unite into one uniform ſubſtance: and in this form they aſcend to the Receptacle of the Flower.

In tracing the courſe of the ſix ſubſtances of which the Stalk is formed, we find them in the following order.

The outer Bark of the Root having terminated in the Scabbards at the baſe of the Stem, the ſix remaining ſubſtances only can form the Plant. Of theſe the inner Rind of the Root being now become the outer Coat of the Stalk, continues its courſe up to the Leaf, Fig. 1. c, where it terminates entirely. The Leaf is formed of this whole Coat expanded, and of a portion of the Blea, and ſome branches of the Conic Cluſters; all uniting, and ſpreading outward, and dividing into ſix principal parts, with ſeveral ſubdiviſions; inſtead of continuing their upright courſe, in form of a Stalk. Indeed this horizontal direction which the Rind, with the other ſubſtances, takes in the place of its firſt perpendicular one, is not ſo ſuddenly performed as may be imagined. At firſt the Rind terminates at this place, and ſpreads in breadth, and forms the Leaf: but that Leaf is continued in the ſame direction that the Rind was upon the Stalk, and makes the original covering of the Flower.

This Rind, tho' it appears a ſimple ſubſtance to the naked eye, is, indeed, compoſed of three parts, a central Vaſcular Subſtance, and two in-

veſting Membranes. Now tho' there be no Joint in this Stalk, as in the Anemone, and ſome others, where a new Footſtalk riſes to the Flower, yet we ſee in the part where this Rind leaves its office of a Coat, to aſſume the form of a Leaf, its three parts appear very diſtinctly: for the Vaſcular Subſtance between the two Coats enlarges to many times its original thickneſs, and conſtitutes a kind of ſwelling, by the great dilatation of the Veſſels, but there is no Gland formed; there is no convolution, or interweaving of the Veſſels, they ſwell at the termination of the Rind, in order to begin the Leaf, and nothing more.

THIS gives the naked eye a view of the real conſtruction of the Rind of the Plant. For the ſwelling of the vaſcular part in its center ſeparates the two Membranes to a diſtance, and when the Stalk is ſplit in this part, one ſeems to riſe at a ſmall height above the other, with the Blea, in a thin coat, between. This appearance, however, deceives the eye, and is immediately ſet right by the Microſcope. The whole Rind which forms this Leaf, terminates in it; and what we ſee is only the ſwelling of the Vaſcular Subſtance between its two Films, making a kind of bed for the portion of the Blea, and for the Conic Cluſters, ſent as Ribs into the diviſions.

THIS being removed, we find the remaining Plant compoſed of only five ſubſtances, a Blea, the Vaſcular Series, a Fleſhy Subſtance, the Conic Cluſters, and a Pith; and crowned with a Flower, perfect, tho' without any Leaf under it; or any Stalk above the place of the inſertion of the Leaf. The Rind terminating in the Leaf, only five of the eſſential parts remain for the conſtruction of the Flower. The outer part, or Blea, is conſiderably thick and white. It reaches no higher than the Petals, and by degrees expands into them, and ends there. This Blea, like the Rind, has its outer and inner Coat; tho' they are extreamly thin, and its central Vaſcular Subſtance much thicker: and in the ſame manner it forms the Petals. Each of theſe, tho' very thin, is compoſed of two Membranes and an intermediate Subſtance: theſe Membranes become yellow, where they riſe looſe to the air; and that is all their difference from the Blea, in its proper place and form.

THE Petals being all removed, we ſee the Fleſhy Subſtance of the Stalk, which has here acquired a greener colour, running its ſtrait courſe to the Filaments, in which it is to terminate. But over it, on the outſide, there lies a yellowiſh Membrane; ſwelling, in form of cords, in certain places. As the Fleſhy Subſtance of the Plant, like all the other parts, is compoſed of Veſſels with Membranes encloſing them, it might appear that this was the

the outer Membrane of that part itſelf; but there is none correſpondent to this within; and it is found ſeparable from the Fleſhy Subſtance, and is entire; and has its riſe and termination altogether diſtinct.

IT is a peculiar ſubſtance in the original conſtruction of the Plant; the Vaſcular Series: it is thrown off by the Fleſhy Subſtance at the crown of the Root; it accompanies that all along the Stalk; but it is ſo preſſed between that and the Blea, that it is not to be ſeen diſtinctly otherwiſe than by this diſſection; which ſhews all the parts in order.

WHEN we have taken off the Blea of the Stalk of this Plant, in the careful manner of the reſt, we may next ſeparate this yellowiſh Coat from the Fleſhy Subſtance, without violence; and beginning at the baſe of the Stalk it will be drawn off freely, all its length to the very top: there it ſticks, and the Stalk muſt be then laid in maceration in warm water, for ſome hours: for if any violence be uſed, we break the parts, inſtead of ſeparating the whole.

AFTER this repeated maceration we may re-aſſume the buſineſs. The yellow Coat will come off clear and entire: the Filaments remain in their full number; but together with this Coat come off certain oblong tubular bodies, reſembling ſmall gaping Flowers. Theſe are the Nectaria of the Plant, and are altogether like thoſe of Hellebore, to which Genus it belongs.

WE ſee here is a peculiar organ in the Plant; and we are no longer to wonder that there was a particular Coat to form it.

WHEN we have got theſe off, with the Coat which terminates in them, we ſee what neceſſity there was of care in ſeparating that part gently from the reſt of the Plant, in order to preſerve them with it; for they adhere to it by ſo very minute a baſe, that now they are ſeparated from the reſt, they drop off with a touch.

THERE are five of theſe peculiar Bodies in the Flower; and the riſing lines like cords in the yellow Coat, from whoſe extremity they ſpring, are the continuations of theſe five Bodies down to the Root: the membranous matter between only ſerving to connect them together and hold them in their places.

EACH of theſe Nectaria is compoſed of two parts, a Body and a Footſtalk. See Fig. 6, Letters a and b. The Footſtalk is flat and greeniſh; the Body is fleſhy, and of the colour of bees-wax. It is hollowed like a ſpoon; ſplit at the top into two parts, and covered half way with a Lip. It is thick and ſoft, full of this yellow tough Juice; and is compoſed of the whole body of the Coat whence it riſes, the two Rinds covering the Vaſcular Subſtance between.

THE

THE Flower properly conſiſts of Two SERIES of Petals, three in each; the three outer are LARGER, the three inner much leſs; and they are all OBLONG. Immediately within theſe riſe the tubular Bodies juſt named. They have no connection with the Petals: they riſe between them; and they ſeem to ſerve a double purpoſe, firſt to aſſiſt in defending the riſing Antheræ from injuries, where there are gaps between the Petals; and afterwards to ſecrete that yellow Juice juſt named, and deliver it to the Filaments. They communicate with theſe by large Veſſels at the baſe. This yellow Juice is wax; and being indiſſoluble in water, it very happily defends the particle of the Fleſhy Subſtance lodged in each grain of Farina for a new Plant.

NEXT within theſe Nectaria riſe the Antheræ. They are EIGHTEEN in number; and each of the Nectaria communicates with three of them. Within theſe appear the Rudiments of FOUR Seed-Veſſels.

THIS is the ſtructure of the Flower; very different from the general character of the ACONITES. We have ſeen how the Fleſh is continued up into the Filaments: theſe are now the outermoſt ſubſtance of the Flower; and the outer Coat of the Stalk is that Fleſhy Subſtance. A ſlip of this, being carefully raiſed from the Conic Cluſters and Pith, brings away three ſeries of Antheræ with it, in which it terminates: its whole ſubſtance dividing into them at the head, where there is a very ſmall Receptacle formed of the white ſpungy parts of the Conic Cluſters.

WE know the Fleſhy Subſtance conſiſts of a vaſcular Matter between two Coats: and ſo do the Filaments. Each is a tube formed of theſe three ſubſtances; and each ſupports an Anthera, which is large, yellow, and appears double. Fig. 6, c.

THE Footſtalks of theſe Antheræ are the Filaments. Theſe are not brittle as thoſe of the Nectaria; but ſo tough, that it is not eaſy to ſeparate them without violence. Being pulled downward, they take off a ſmall piece of the Fleſhy Subſtance with them. They are very elegantly formed.

THE Footſtalk, or Filament, at its baſe is rounded; but it grows broader and flatter toward the top. The Anthera, in many Plants, is fixed to the Filament by an extream ſmall neck, but here it is the largeſt part, which ſuſtains it. In thoſe the Anthera ſeems a diſtinct body faſtened on the Filament; in this it is a plain continuation of the body of the Filament itſelf, into two ſwellings: we ſee that diſtinctly here, which is really the caſe in all.

THE ZERUMBETH, and many other of the Aſiatick monandrous Plants, have a divided Anthera: and ſome have thought LINNÆUS did amiſs to

claſs them in his firſt tribe; calling the divided Anthera two. But that great Author judged much better than theſe Criticks: he calls the ſeeming two Antheræ, the two parts of one divided Anthera, connected by a Membrane: and Nature, in other inſtances, avows the truth of it.

In the AMARYLLIS each Anthera diſtinctly conſiſts of two tubes, within one common Membrane, preſſed cloſe together. In the AMOMUM ZERUMBET, the Anthera is alſo compoſed of two bladders of Farina; and they are not preſſed together, but lodged ſeparate at a diſtance, within one common Membrane. It is the ſame in this Plant: Each Filament is one ſubſtance, wrapt in one Membrane, and yet the two Bladders of the Anthera are ſo diſtant, that they appear two Antheræ to the Microſcope.

Their true formation is this. A portion of the Fleſhy Subſtance of the Stalk ſeparates from the reſt, and runs up in form of a Filament. Its own outer Membrane covers it; and within is a vaſcular ſubſtance, and an inner Membrane. The inner Membrane does not go up regularly as the outer, and line the ſimple tube it forms: but ſpliting lengthwiſe, it rolls each way inward, and by this means the Fleſhy Subſtance being connected to it, and rolling with it, there are formed two leſſer tubes within the original one. See Fig. 6, d. Each of theſe has a ſmooth Membrane to line it, which was the inner lining of the original body; and its outer ſurface is the naked vaſcular part of the Fleſhy Subſtance; naked as to the individual tube; but ſafe from injuries, being covered in both with the outer Membrane.

These Tubes diverge as they riſe; and at the head each forms a kidney-ſhaped ſpungy body, of a yellow colour. Theſe are ſtill contained within the outer Membrane, which covers the Filament and Antheræ entire; and there appears a part of it between them.

Thus does the Fleſhy Subſtance of the Stalk terminate in many oval yellow bags. Theſe are compoſed of its Vaſcular Subſtance; and from theſe, particles riſe in form of globules of Farina, and ſeparate continually as they grow dry in ripening. Each particle takes with it a covering of the inner Membrane, which lines the bags equally with the tubes; and into this is thrown a little of the waxy matter, ſecreted for that purpoſe in the Nectaria, and conveyed, by communicating Veſſels, up the tubes. Theſe very Veſſels are ſeen diſtinctly before a good Microſcope, at their entrance into the Filament, and up the whole length of it. They enter near the baſe, two into each Filament; and they run up like yellowiſh cords along the ſurface of the Filament, juſt under the outer Membrane.

Each

EACH particle of the Fleſhy Subſtance of the Plant, thus ſeparated in the body of the Anthera, cloathed with a Skin from its inner Membrane, and covered with a little of the waxy Juice, is a globule of Farina. Every particle of the Fleſhy Subſtance of a Plant is capable of growth into a whole Plant of the ſame kind; for its ſeveral Coats are formed from its own Juices, and the very organs of a Flower are its natural terminations. Therefore this particle, in a globule of Farina, is capable of growth into an entire Plant: it is tender, but it is well defended: for even in this globule it is ſurrounded with wax, and covered with a Skin; and is thence delivered to the Seed, where it is ſafe till ſown.

HAVING thus cleared away all the Coats of the WINTER ACONITE, there remains a divided column of Pith, from the ſummit of which grow four Seed-Veſſels; but ſtill it is not the abſolute naked Pith which riſes to the very ſummit of this column. Where the Leaf, the Petals, the Nectaria, and laſtly the Filaments, have been torn off from it, its naked white and ſpungy ſubſtance makes the ſurface; but theſe have not reached to the abſolute ſummit of the column. There is a ſmall conic eminence, the head of the Receptacle, above the place where the Filaments were torn off, and juſt below the baſes of the Seed-Veſſels: this above has a kind of covering: it is a yellowiſh green ſubſtance, and ſhews itſelf even to a moderate magnifier, to be more than a mere Membrane. It is, indeed, a part of the Conic Cluſters of Veſſels which riſe within the Fleſhy Subſtance of the Plant. That original part terminates in the Filaments: nor is there any need it ſhould go farther: the parts which ſeparating form thoſe Filaments, are each of them perfectly diſtinct, and one as well as another equally capable of a new Vegetation. When this Fleſhy Subſtance has terminated there in that manner, the Conic Cluſters of Veſſels preſſed cloſe together, continue their courſe a little higher, and form this part, which is the very ſummit of the Stalk. This appears an arch in a perpendicular ſection of the Plant; but when cut off tranſverſely near the ſummit, it forms a kind of dome, of a pale green ſubſtance, filled with the white Pith, and pierced with four diſtinct, and not very minute, holes.

THRO' each of theſe riſes a column of the Pith; which a proceſs of the yellowiſh Coat of the Crown covers, and theſe make the four greeniſh Seed-Veſſels. The Conic Cluſters are thus continued, in a ſmall portion, to the very ſummit of the growth, and principally form the Valves of the Seed-Veſſels, which the thin Membrane, covering the Pith, lines.

THE Pith itſelf here, in its extreme growth, breaking into pieces, forms a kind of white filmy Bladders, with a ſpungy ſubſtance in them; and into theſe

theſe are received the little particles of the Fleſhy Subſtance lodged in the globules of Farina: they are then perfect Seeds, and ready to grow.

THE way by which theſe covered morſels of the Fleſhy Subſtance get into the Seed, is obvious. The tops of the Seed-Veſſels riſe in a kind of Stigmata, or dewy heads, with open tubes, covered with a ſhining moiſture: on theſe the globules of Farina fall; and burſting there, the ſeparated particle, with its wax, makes its way down the future, to the open baſe of the Seeds; in which being lodged, it is called the Plantula Seminalis.

THE Figures in Plate XI. ſhew the principal of theſe parts, with their ſeveral terminations, diſtinctly, as they appear to the naked eye entire, divided and ſeparated one from another. Fig. 1, expreſſes the entire Plant in its natural ſize, with all its parts. At Fig. 2, is repreſented the ſame Plant ſplit down from the Flower thro' the Root, to ſhew the diſpoſition of the Fleſh in the Root, and the origination of the Stalk. Fig. 3, ſhews a ſection of the Footſtalk of a Leaf, with its ſix Conic Cluſters of Veſſels. Fig. 4, a ſection of the Flowering-ſtalk near the ground, where they are twelve, and are diſtinct. At Fig. 5, is repreſented a ſection of the neck of the Stalk near the Flower, where they are preſſed cloſe together by the ſmallneſs of the Stalk. Fig. 6, expreſſes a Filament and Nectarium, enlarged by the Microſcope. And the remaining Figures ſhew the ſeveral Coats and conſtituent ſubſtances, as they come off entire, by means of a long maceration, and careful management.

FIGURE 7, ſhews the outer Rind of the Root; which, being taken off entire, terminates in the Films, defending the baſes of the Stalks, and is not continued at all into them, or upon them. The inner Rind is repreſented at Fig. 8. This forms the Leaf on which the Flower reſts; and terminates in it. The next Coat or Blea is repreſented at Fig. 9, forming the Petals of the Flower; and terminating in them. At Figure 10, is ſhewn the Vaſcular Series alone and entire, terminating in the Nectaria, and forming them entirely. At Figure 11 is ſhewn the courſe of the Fleſhy Subſtance of the Plant, terminating in the Filaments. And at Fig. 12, the Pith, in three disjointed pieces; one being the Pith of the Root, a ſecond of the Stalk, and the third of the Seed-Veſſels. The Conic Cluſters are diſpoſed in this Plant exactly as in the Hellebore; and, therefore, as they could not be repreſented diſtinctly in a Figure of this ſize, it is better to refer back to that Plate.

HAVING thus ſeen diſtinctly the ſtructure of the Plant, we ſhall be able to trace the courſe of its Juices thro' thoſe ſeveral parts we have examined; and we ſhall find here a much more complex body than the Colchi-

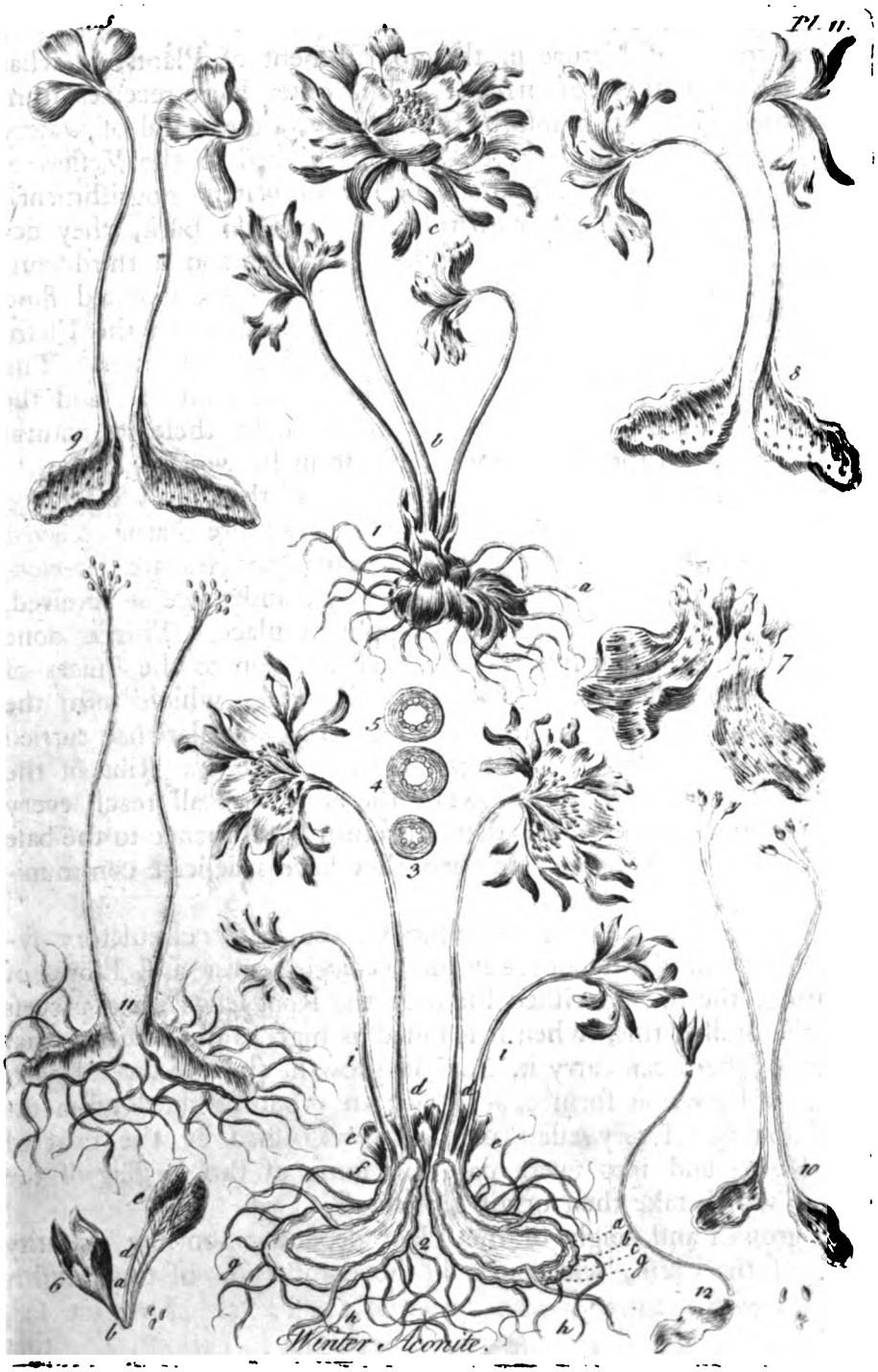
cum, ſupported by a ſingle ſyſtem of Circulation in the Root, with a ſmall help from the Conic Cluſters.

THE general courſe of Nature in the nouriſhment of Plants, is what we have ſeen already in the COLCHICUM. The outer Bark receives from the earth, evaporates, and again abſorbs from the air, a great deal of watery matter; of this a ſmall portion is ſecreted, and delivered to the Veſſels of the inner Rind: they receive alſo their portion of watery nouriſhment; and make their ſecretions, which, with thoſe of the outer Bark, they deliver to the Blea. In the Blea a new ſecretion is made, and a third concoction is given to the firſt of the other Juices; and this elaborated fluid being now fit for the nouriſhment of the Plant, is conveyed to the Fleſh. There it circulates; and thence begins the growth of all the parts. The Vaſcular Series is formed on the ſurface, and the Conic Cluſters; and the Pith, within; and proceſſes of the Fleſh accompanied by theſe its natural productions, riſe to form the Stalk, and terminate in Flowers.

ALL this depends upon the force of a Circulation in the Fleſhy Subſtance of the Shell or Coat, g, Fig, 2, Plate XI. The moiſture that is received by the Root, and by the Leaves, when its nutritive particles are ſecreted, is, in part, evaporated during the heat of the day; and more is received, replete with the ſame kind of particles, to ſupply its place. This is done continually; and, therefore, there is a continual addition to the Juices of the Fleſh. This redundance forces up thoſe Proceſſes which form the other parts of the Plant; and all the time a ſecondary Circulation is carried on by the Veſſels of the Conic Cluſters. Theſe make the Ribs of the Leaves, and the Receptacle of the Flower; therefore they all reach every where the extremities of the Plant: they all return from thence to the baſe of the part whereto they belong; and there they have a delicate communication with the Fleſh of the Root.

THUS, in the Plant now under examination, the ſingle circulatory ſyſtem is in the Fleſh of the Root; but the Radical Leaves and Fibres of the Root aſſiſting, the full nouriſhed Fleſh of the Root ſends up a proceſs which forms the Stalk: this, when it is raiſed as high as the force of that ſingle circulatory ſyſtem can carry it, ſtops its growth, and the ſeveral parts then ſeparating, a Flower is formed, in which are produced the Rudiments of many new Plants. Every eſſential part is nouriſhed by the coat of Fleſh in the Root; and into every part run ſome of the Veſſels of the Conic Cluſters, which take their origin from it.

THAT the growth and height of the Plant depend upon the quantity and diſpoſition of the Fleſh, will appear in the compariſon of the heights of ſeveral Plants with the quantity and place of the Fleſh. Thus we ſee, that



that in the COLCHICUM, where the whole head of the Root is extremely thin, and conſequently the Fleſh of it in very ſmall quantity, all that is raiſed from it is a Flower without a Stalk. This we accounted the firſt and loweſt ſtage of growth. In this WINTER ACONITE the Root is thick, and the quantity of Fleſh very conſiderable, and conſequently a Leaf as well as a Flower are formed, and a Stalk raiſed three or four inches high, to ſupport them. This is alſo the caſe in the Hellebore: and from theſe, and a number of other obſervations, it ſeems to me, that three or four inches, or thereabouts, is the height to which a ſingle ſyſtem of Circulation naturally carries up a Stalk.

FROM this we ſhall advance to the conſideration of a Vegetable Body yet ſomething more complex, ſelecting the ANEMONE; whoſe Stalk is conſiderably taller, tho' it have no more Leaves than this; but whoſe advance in height requires a ſecond ſyſtem of Circulation.

THE courſe of theſe experiments on the WINTER ACONITE, ſhewed me accidentally, that it is capable of yielding, with Steel, a crimſon Dye, perhaps equal to that from Cochineal.

CHAP. XXXVII.

Of the ANEMONE.

IT is by the moſt gradual advances we muſt expect to arrive at a knowledge of Nature; for all her changes are made by ſuch advances only: there is no great gap in her everlaſting chain; nor can we ever rightly follow her courſe, unleſs we mark all the gradations.

FROM the ſtalkleſs COLCHICUM we have continued our reſearch up to the conſtruction of the WINTER ACONITE, whoſe low Stem one circulatory ſyſtem is able to nouriſh and ſupport: but more of theſe are neceſſary to taller Plants; and in the ANEMONE we ſhall find diſtinctly two; the firſt ſeated as in the preceding Plant, in the body of the Root; the ſecond in the lower half of the Stalk.

THE Fleſh in the Root of the ANEMONE fed by its Fibres, and its Radical Leaves, ſends up a thick Proceſs of itſelf, in form of a tubular Stalk, which gets in the free air all its coverings. This riſes by the ſtrength of the Circulation in the Root, to the height of four inches, or ſomething more, above the ground; but as the Stalk is to be carried up a ſecond ſtage, there is a new ſyſtem of Circulation formed.

As the Fleſh of the Root forced up this lower part of the Stalk, the Fleſh of this lower part forces up this upper half. A circulatory ſyſtem is neceſſary for this; and Nature has given one: for the Fleſh of the lower part of the Stalk makes an arch, and returns upon itſelf, at the place where the Leaf grows; and a Circulation is carried on in this part as evidently as in the Root; from whoſe force ariſes the ſecond Joint of the Stalk, ſupporting the Flower.

I PLANTED an ANEMONE Root ſo late in the ſummer, that it ſhould not flower till late in winter. December the 17th I took it up in full bloom; and found, on cleaning the Root, that ſince the planting it had, beſide the Flower, produced ſome NEW PARTS. The Root, when put into the ground, conſiſted of a tuberoſe head, and from this grew five proceſſes, of different lengths, with UNEVEN ENDS: the whole was dry, hard, and of a duſky brown; only at the crown appeared a thick part paler than the reſt: this was the principal Bud.

WHEN taken up, the five Proceſſes were grown much longer; and there were ſhot out from the head the Rudiments of two others, in form of Buds. The whole Root was of a pale brown; and four of the proceſſes yet paler; but the fifth, which lay loweſt, and was a continuation of the head of the Root, was of the ſame brown with that part.

FROM the head of the Root, and from this undermoſt Proceſs, grew many looſe Fibres; from the others none. This part, therefore, is the only one in an ANEMONE that is properly to be called a Root. It is in this ſtate of the Plant the natural body of the Root, altho' it has been one of the common Proceſſes originally. The others are lengthened Buds; and nothing more. They are thus formed.

WHEN an ANEMONE Root is taken out of the ground, there is on its Crown a Bud, which contains the Rudiment of the next year's Stalk and Flower. When this Root is planted, Nature not only ſends up the Stalk from the Bud, to produce Flowers and Seeds, but, careful of accidents, ſhe ſends out alſo other Buds, which are to propagate and increaſe the Plant from the Root. Theſe appear upon the head of the old Root; and they are Shoots from the Fleſh. Which from themſelves form a Pith, and puſhing out the Coats of the Root, and making their way to the ſurface, there appear in ſeveral conic bodies, covered with many filmy ſcales; theſe ſcales are formed of the three outer coats of the body of the Root, which having been all puſhed out by this Shoot from the Fleſh, throw off imperfect Films from their ſtretched parts, which ſerve to defend the tender Plant or Embryo contained in the Shoot.

WHILE

WHILE the Plant flowers, these are filled with nourishment, and they grow, and thrust out farther from the Root: they become lengthened to an inch or more; and the lowest Films being always left upon the Process, that whole part has a scaly surface. See Plate XII. Fig. 2, *a a a*.

WHEN the Process has attained this length, it is in a state of growth for a new Plant. It may be broken off from the original Root, and put into the ground. The wound being only at the end of the body, is of no consequence; the Bud which was the original of the whole remains unhurt at the other end, and forms a Crown, Fig. 2. *b*; from which a new Plant rises.

GARDINERS take these Processes, for parts of the Root; but they should distinguish better. No Fibres grow from them while they adhere to the Root; nor does their extremity shoot in length, as the ends of Roots do; but keeps its original form; while the scales which cover it, give it a ragged appearance.

WHEN one of these Processes, which we see are only lengthened Buds, is broken off from the old Root, and planted in the ground, it takes a new condition. While it remained fixed to the body of the Root, it had its nourishment thence, and therefore needed not to shoot out Fibres: but when separated, and planted, the lengthened part by which it was joined to the Root, assumes the condition of the bodies of other Roots, and sends out Fibres to draw nourishment for the support of the embryo Plant, which is now ready to shoot from its Crown.

THE base of the Bud, Fig, 2, *c*, where it originally rose from the surface of the old Plant, swells first, and forms a head of a Root, just such as that from whence it sprung; the whole exterior part of the Bud then lengthens and enlarges; and Fibres are shot out from the lengthened part of the Process. Presently the scales of the Bud, separated by its increase in length, open, and there burst from them Shoots; but these are only Rudiments of Radical Leaves, *d*. The Crown itself remains unopened, and the embryo Plant for flowering does not yet grow. There requires the assistance of the Leaves for that effort.

THE second year this Crown opens, and the Flowerstalk rises: and at the same time new Buds burst forth upon the head of the Root near the Crown; such as in the old Root gave origin to this; and these lengthening into so many Processes, are ready afterwards to be separated from the Root, and grow.

THIS is the propagation of the ANEMONE by increase of Root: and three years are necessary for the full procedure. The Bud which is formed

ed this Autumn, 1758, will be a long Proceſs in 1759, fit to be ſeparated from the Root; in the year 1760, this will ſend up Leaves, and in 1761 it will flower; and new Buds will then be formed from it.

HERE let us reſt, and wonder! the proceeding of Nature, thus explained, is ſimple and familiar; but how delicate it is; and how long time is required for it! The ANEMONE which I have now before me, December 1758, was formed in the Autumn of 1755; and has been all this time nurſed under the boſom of the earth, and under covert of innumerable ſcales. It is a piece of the original Root, and has been all thoſe years forming: firſt nouriſhed by the Root, and then by Fibres of its own. This we find is the conſtant courſe of Nature, by taking up the Root at various ſeaſons, in ſucceſſion. And certainly it is worth the while to enquire, What is the internal ſtructure of the increaſing Bud from its firſt appearance; how the young Plant is formed; and by what ſtages it attains perfection.

THE Rudiment of a new Bud is alway formed at the time when a Stalk ſhoots from the Root for flowering: the ſame force of Nature effects both theſe purpoſes; therefore the firſt enquiry after the origin of a Bud, muſt be in a Root juſt ſending up its flowering Stalk: and to avoid confuſion of parts, it is beſt to chuſe a new Root, juſt puſhing for its firſt Flower.

DISSECTING this Root lengthwiſe, we find it is compoſed of the uſual ſeven parts; 1. a brown outer Bark; 2. a whitiſh ſpungy inner Rind; 3. a white Blea; 4. a Vaſcular Series; 5. a Fleſhy Subſtance, which is reſinous and yellow; 6. a ſeries of Conic Cluſters of Veſſels; and 7. a vaſt Pith. This is the conſtruction of the body of the Root. The Head has the ſame compoſition exactly; but the Pith bears more than double the proportion there to any of the other parts. This exactly receiving water as a ſponge, cauſes the ſwelling; and from the Fleſh covering it there, riſe the Shoots. The interior part of this Head is ſtill terminated by its original and proper Bud; and from this riſe the Stalk and Leaves; the Stalk from the end, and the Leaves on each ſide.

IT was in the year 1756 I began theſe enquiries; and I ſelected for the purpoſe a number of young Roots, then ready for their firſt bloom. Upon one of theſe I began the experiments; and the reſt were planted in the uſual manner the ſucceeding years, to mark the formation and progreſs of the Bud, which afterwards was to be a compleat Root.

A FLOWERING Root of the kind juſt mentioned, being ſplit lengthwiſe, we ſee the whole ſubſtance of it is contracted, at the upper extremity, into a kind of neck; and thence ariſes the Stalk, Fig. 2, *e*.

THE

THE Neck, or part between the Root and Stalk, has the form of a ſmall ring; and ſeems to divide them one from the other. The Stalk, on a ſlight view, might ſeem rather fixed upon the Root than riſing from it: but the Microſcope ſhews the wonderful mechaniſm, and it is this.

THE outer Bark, the ſpungy inner Rind, and the Blea, all run up in a continued line from the Root: but the Fleſh, at the union of the Root and Stalk, forms an arch: from which riſes a proceſs or part of the ſurface, forming the Fleſh of the Stalk; which ſoon gets thoſe coverings as it riſes.

THUS is the Stalk continued from the Root, and is truly a lengthened Proceſs of that part, extended upwards. When the force of the Root ceaſes, at a certain appointed height, being the utmoſt the circulatory ſyſtem of the Root can effect, a ſecond ſyſtem is formed; and when a new Stalk is forced up from this, as the firſt was from the Root, and has reached its utmoſt heighth, the parts open into a Flower. The three outer Petals, *f*, are formed of the exterior Rind of the Stalk; the inner Bark forms the three innermoſt Petals, *g*, and there terminates: the Vaſcular Series terminates in a thick Ring, h: the Fleſhy Subſtance forms the Antheræ, i: the Conic Cluſters make a Receptacle, k; and the central Pith forms the Seeds. So ends the Stalk; and theſe Seeds ripening, produce new Plants: only continuing to grow.

THE eſſential part to a Plant is in this, as in all others, the Fleſhy Subſtance of the Stalk: and a piece of this is lodged in every globule of Farina; which being ſheltered from danger in the Seed, afterwards grows.

OF this we have already treated at large: it is the Root we are properly examining here. While the principal part, or main body, of this Root, is thus continued upward in a Stalk for flowering, the Fleſhy Subſtance, furniſhed with abundant nouriſhment for the growth of the Stem, ſwells out alſo a little on one ſide, near the Joint, where the Root ends and the Stalk begins. The time of this ſwelling is juſt when the Flowerſtalk is riſing; and its firſt appearance is a YELLOWISH Knob or LUMP, viſible only by the Microſcope.

THE origin of this is juſt ſuch a PARTICLE as that which is to be afterwards lodged in each grain of the Farina, and thence delivered to the Seed; and having the ſame vegetative power, or Principle of Life with that, it grows in the ſame manner. It is already in the ground; it is as ſecurely bedded in the body of the Root, as the other can be in the Seed; and having an immediate ſupply of nouriſhment from the very Fibres of the Plant, it directly grows.

NATURE is wonderfully uniform in her courſe; and whenever we think otherwiſe, it is becauſe we do not underſtand her operations. It was not known, till from ſome former obſervations I was ſo happy to make, that the Rudiment of the future Plant was in the globule of Farina; and that it was only a particle of the Fleſhy Subſtance of the Stalk: but now that is demonſtrated, we ſee that the little lump, firſt formed for the production of a Bud, is the very ſame thing; and we have the ſatisfaction to find, that in each of theſe ſtates, diſtinct and unlike as they ſeem, the ſame courſe of time is required to bring them to maturity. When the ripened Seed is ſown, the third year ſhews the Flower: and in the ſame manner three years ſerve to perfect this Radical Lump into a Flowering Plant.

IF the Seed be kept ſafe out of the ground a year or two, it will yet grow, when ſown; and if the Bud formed from the Radical Particle be at its due growth, ſeparated from the old Root, it will, in the ſame manner, bear to be kept a long time out of the earth; and yet will grow when planted. The caſe is juſt the ſame. The Seed and the Root ſerve equally as coverings for this living Particle of the Fleſhy Subſtance; and ſo long as they are kept from mouldineſs, fermentation, and decay, that Particle is always ready to grow.

THE new-formed Lump on the ſide of the Root is in the ſtate of the Rudiment in the Farina; and powerful Microſcopes will diſcover in this, as in the Seed, a cluſter of Fibres toward the top, which are arranging themſelves for the Formation of the Plant to come. Soon afterwards their form becomes more diſtinctly viſible.

THE new-formed Lump puſhes outward, and ſoon ſhoots inward a Pith, its proper lining. The firſt formed Particle cannot do otherwiſe; for it is a piece of that ſubſtance of the Root from which the Pith grows. In a few weeks this Lump, which was at firſt only a yellowiſh ſpot, becomes a LENGTHENED STREAK; making its way in a direction a little OBLIQUE, and pointing upwards, toward the outſide of the Root.

SOON after it forces out the BLEA of the Root, its ſpungy inner Rind, and its outer Bark; and is thruſt, together with them, to the level of the ſurface, and preſently after beyond it. It is not there naked; for the ſeveral outer Coats of the Root which it has carried out with it, ſend forth, from their ſurfaces, a multitude of filmy ſubſtances, which encompaſs it as ſcales, forming a proper Bud; as regular as that upon the moſt common Tree.

AT this period, when the head of the Bud is advanced toward the free earth, the crown of it contains that cluſter of Fibres firſt ſeen, ſomething more

more advanced; but ſtill ſo unfaſhioned, that none but thoſe who know what they were to expect, would find there the leaſt reſemblance of the ſucceeding Plant. This may be called, for diſtinction, the Rudiment in its ſecond ſtage.

FROM this time theſe ſeveral parts of the ſucceeding Plant grow ſomething more diſtinct, as the Bud increaſes; till at the end of that ſummer, when the Bud is full formed, and the Roots are ready to be taken up, the complex body has at its top ſomething like the Anemone Flower. This may be called its third ſtage.

WHEN the Root, with this Bud upon it has been planted again, and has remained its flowering ſeaſon in the ground, on taking it up, the Bud is found lengthened into a Radical Proceſs; and the Crown of it being ſplit open, there is ſeen the Rudiment of the ſucceeding Plant, in its fourth ſtage. Its place is near the Crown; and ſomewhat on one ſide: and to the unaſſiſted eye, it appears but as a ſmall duſky ſpot: but the power of the Microſcope ſhews now the form of the whole ſucceeding Flower, except the Petals.

THIS want of the moſt ſhewy part, would miſlead the common eye; but thoſe accuſtomed to natural reſearches, know the moſt eſſential are always firſt formed, and thoſe of leſs importance afterwards. We know the Rudiments of Seed are the moſt eſſential in this caſe; and therefore they are to be firſt expected viſible: we ſee them accordingly: not in their proper form of Seeds, for they conſtitute the inner Petals in this Double ANEMONE; and they have, even thus early, a tendency to that ſhape. The appearance now is an oval body, ſurrounded and covered with Films. The Stalk is all this time inviſible, and even the very Rudiments of the outer Petals.

WHEN this Proceſs has ſtood its due ſeaſon, it will ſhoot up a Flowering Stalk; whether it be ſeparated from the Root, or planted again with it. If we take up ſuch a Root when it has been a month in the ground, we find the young Flower in the center much more diſtinct: the ſix outer Petals are plainly formed, and they ſoon increaſe in ſize. This may be called the fifth ſtage of the young Plant: and after this the proceſs to a perfect form is much more rapid.

AFTER one ſeaſon more this new-formed Plant is to ſhew itſelf above the ground. Taking up the Root ſoon after planting at that period, we find the young Flower much more diſtinct: but covered by long and pointed purple ſcales, it now reſembles a Roſe in its Bud, with the jagged end of the Cup about it: and one would be apt to think the ANEMONE had

originally a Cup like that Flower, tho' it never appeared above ground. This is the ſixth ſtage of the Rudiment.

THE ſeventh is to be ſeen ſomewhat later in the ſame ſeaſon; and that explains all. The Proceſs being now become an abſolute Root, and the young Plant ready to riſe from it, we ſee the Flower yet more perfect; and find thoſe purple Films which ſeemed a Cup, are really the Rudiments of that peculiar Leaf which is placed about the middle of the Stalk in the full-grown ANEMONE: there appears alſo now, and never before, the Rudiment of a Stalk, uniting the Root and the young Flower. This is the laſt ſtage of the embryo Plant: what follows is done above ground, and open to all eyes.

THE Bud pierces the ſurface of the earth, ſupported by its ſhort Stalk, and with its top downwards. The end where it is joined to the Stem is defended by the Leaf which is to expand upon the middle of the Stalk; and this makes it able to reſiſt injuries. Its form is that of a Swan's Neck; and the extremities of that particular Leaf make a kind of Fringe to the bent part, Fig. 1, *a*.

FROM this time it grows faſt: the Stalk lengthens, the Head ſwells, and from the bigneſs of a ſmall Pea is ſoon equal to a large Bean, *b*. At four inches height of the Stalk, the Leaf which has hitherto been cloſed about it opens; and the Stalk loſing its bend at the top, becomes nearly erect, Fig. 1, *c*.

THE Bud of a Flower is now large, but green; and ſits cloſe upon the boſom of that Leaf; as the Flower of the YELLOW HELLEBORE, which we call WINTER ACONITE; before deſcribed. From this time the progreſs to perfection is ſwift: a Stalk ſhoots up from this Leaf; that is, the Stem of the Plant, which has hitherto been terminated there, riſes by a new growth from it, as from another Root.

THE Flower is then ſupported at two Inches above the Leaf which hitherto defended it, performing the office of a Cup: and the Petals, which were hitherto green, become red, the Plant is now in its perfection, Fig. 1, *d*. The original ſix Petals of which the Single ANEMONE was compoſed, have ſent up from the ſame baſe a number of other large Petals like themſelves; the pale Filaments originally crowned with yellow, are converted into a kind of crimſon clubs: their form, in ſome degree, remaining, tho' their colour and qualities are loſt. Theſe make a crimſon fringe juſt within the baſe of the Flower, *e*; and what in the Single or natural ANEMONE were Rudiments of Seeds, ſwell here into narrow, coloured Petals; and conſtitute the great doubleneſs, *f*.

THIS

THIS is the Fact: but it will be useful also to explain the manner. To understand this justly, we must begin at that spot in the Plant where resided the original Principle of Life; and trace it thence, downward to the extremest Fibre, and upward to the Flower. This strict enquiry carries us back either to the Seed, or first Bud from the original Root: it is equal which we take; for the Principle of Life is the same in both; and its equal progress in either, from that first simple Rudiment to perfection, being the same, they mutually illustrate one another.

THE great Axiom is, that the Fleshy Substance of the Stalk is the essential part of the Plant. In this the power of Vegetation resides; it resides in every part of this; and in no other part of the Plant.

ANY Particle of this which can be preserved from putrefaction in the earth, will grow; and no other part can grow without this. This being planted, will produce all the others; but all the other parts, without this, perish: they cannot produce this; and there is no Vegetation without it. The essential part of the Flower is formed of this, and it is a portion of this lodged in the Seed that grows. The experiments lately made, under my direction, by Mr. BARNES, upon the principles of AGRICOLA, shew this. Every part of a Plant which contains but a particle of the Fleshy Substance, will grow into a perfect one, if kept from putrefaction.

ON this fundamental truth depends all.

A PARTICLE of this Fleshy Substance of the ANEMONE Stalk, lodged in a Seed, or in the center of a Bud, is the Rudiment from which a new Plant of the ANEMONE is to grow. This is at first a speck too small for the sight, unless assisted by the most powerful Microscopes: It is defended by the spungy substance of the Seed, or by the substance of the Root, which grows round about it in the Bud: But this lives; this only lives; and it is the Principle and Seat of Life in the succeeding Plant.

WHETHER a Seed, or a lengthened Bud of the ANEMONE, called a Parted Root, be set, it is from this spot the succeeding Plant rises. It is lodged by the Gardiner's hand, at some small depth under the earth; and there it begins to grow. Roots are sent downward, and a Stalk is shot upwards, each from this one point. This remains always in the succeeding growth; and is the Seat of Life in the Plant. All the rest grow from it: What we call the Stalk, is only a continuation of a part of this upward; and what we call the Root, is, in the same manner, a continuation of it downward: both are extensions only of this point: being of its nature, they contain the power of Vegetative Life, as the original piece does; and being planted, as that was, any piece of them is as ready to grow. This I

have found: for pieces of the Stalk, or of the Root of an ANEMONE, ever ſo ſmall, if covered in the wounded part with Cement, will grow, and become perfect Plants; as pieces of the Polype will become perfect Animals.

WE are now to trace the progreſs of this original point, or Particle of the Fleſhy Subſtance, into a perfect Plant.

WE have ſhewn how it is formed by growth from the head of the Root, and how it gathers ſtrength in three ſeaſons, while yet lodged in ſecret in the heart of the Bud. At the end of that time it is planted out.

THIS ſeparation conſtitutes the Proceſs a diſtinct Plant: till this time it had been a part of the old one. We have ſeen how this acquires its growth, and we will now follow the Seed.

IN this, as in the Bud, is lodged an original particle of the Fleſhy Subſtance of the Stalk of the parent Plant. It is put into the ground, and after ſome days it ſeparates from the Huſk; and we ſee the original Particle naked; it is ſmall, duſky, moiſt, ſpungy, and ſcaly. A few ſlight Fibres firſt ſhoot downwards, and a Film ſoon after covers the firſt Particle, from whence theſe ſpring. This, by degrees, thickens, and becomes the Blea; or that part which in the perfect Plant is to be the third Coat, counting from the ſurface.

THE tender Fibres which were firſt ſhot from the naked Particle, and were themſelves alſo naked, get at the ſame time alſo this covering of Blea; and in the ſecond ſtage of growth, they conſiſt of a ſolid fleſhy matter, and one Coat. They are continuations of the firſt Particle itſelf, and are the ſame in ſubſtance. Their firſt ſtate was nakedneſs; and in this the whole would have rotted and decayed. The ſubſtance of the Seed had defended the Particle before, and now it is robbed of that, provident Nature is giving it a new defence, formed by the ſecretion of its own Juices; as the ſhell of a Snail, or the coverings of other tender Animals are formed.

THE original Particle is covered on the ſurface with the open ends of thoſe tubular parts which, in a kind of chain, form its ſubſtance. The firſt Juices they ſecrete, cover the naked body with a ſlime, which ſoon condenſes, and becomes this Blea, coating the whole down to the extremities of the Fibres. In the firſt ſtage the Rudiment was a ſhapeleſs Particle. In this ſecond ſtage there begins to appear a body of a Root; it is a little lengthened from one end, and gives the Rudiment even already the form of a Proceſs.

IT has been ſuppoſed, the Pith, or central ſubſtance of a Plant, contained the Vegetative Power: but all this time the new Plant is growing, and no Pith is yet formed.

THE

THE Fibres being covered act more vigorously; and soon the Particle, which we may now consider as the body of the Root, swells: the increase is inward: and in the third stage, which a few days bring on, the tubular openings within, send forth a Juice, as those on the surface first did; and this swelling and distending the Particle, forms, by degrees, a Pith. This is equally done in the body of the Root, (for so we may now call the original Particle) and in those Processes of it which make the Fibres: for being two parts only of one substance, the same change happens at once in both. Thus we have the formation of those parts which are to be conspicuous in the future Plant. These stages of growth are arbitrary; and the progression is very swift from one of them to the other. But they are determinate, and distinct: and therefore highly useful.

LET us remember that this original Particle which is to grow into a new Plant, was a part of the Fleshy Substance of the parent Plant, terminating in a globule of the Farina; there it was covered with a waxy matter; and thus covered it was delivered into the shell, which having received it, became a Seed.

ALL these things are extraneous to it: they serve for its preservation; and nothing more. We have seen the Seed planted; we have seen it burst; we have seen the original Particle delivered naked from it, after having first received the beginning of vegetative growth within it; and we are now to follow it into the form of an entire Plant. Its original body swelled, and set to growing, with a few naked Fibres produced from it, was the first plain stage: yet this naked, and almost shapeless morsel, was a perfect Vegetable, capable of growth, and of producing all the other parts. In the second stage, we see a white Coat formed to the dusky spot; and in the third, a Pith formed within it. Three substances are already constituted: the whole Plant consists of only four more, and they soon follow.

THE Blea is formed of the hardened Juice thrown from the ends of Vessels of the Fleshy Substance; other smaller Vessels of the same substance, whose ends were not open, run into this Blea; and take their course along it. These unite the Blea to the Flesh, and one system of Vessels serves them, and runs thro' them: and between these is formed, from the Flesh, the Vascular Series.

THE Blea has its Vessels also open upon its surface, and a Juice is discharged from them, just as was originally from the Flesh; only in less quantity. This covers the new-formed Body and Fibres all over; and condensing afterwards it forms a new Coat upon the Blea. This is the inner Rind of the entire Plant. Vessels are continued out of the Blea into this,

this, and run their courſe up the whole height that it is carried in the ſucceeding growth of the Plant. This is the fourth ſtage of the Seedling Body: and it conſiſts now of five ſubſtances; or more properly, the original Particle has formed three Coats outward, and a kind of narrow inward.

Two more parts are to be produced, and then all will be perfect: theſe are the outer Rind, and the Conic Cluſters of Veſſels. The Veſſels which open upon the ſurface now are few, but they diſcharge ſome fluid: this condenſes as the former had done, and makes another Coat of the Plant, a fourth cover to the original Particle: it is the outer Bark. The Conic Cluſters alſo riſe between the Fleſh and Pith; and all is now perfect.

THUS we ſee of what parts a perfect Vegetable conſiſts, and how thoſe parts are formed. It has been thought all roſe of the Pith: but that led to many errors. A ſection of one of theſe young Roots of an ANEMONE will ſhew the ſyſtem here eſtabliſhed plainly: and tho' it differs a little in the order of production, it is the ſame in all other reſpects as in the former inſtances.

FIBRES have their Pith as well as the body of the Root: but the Pith of the Fibres is not a continuation of the Pith in the body of the Root; nor has any the leaſt connection with it. The Fleſhy Subſtance, which was the original part, is now continued entire round the Pith in the body of the Root; and ſeparates the Fibre wholly from it. That Fibre is a continuation of the original Fleſhy Subſtance, and has the ſame Coats continued; but the Pith itſelf is ſecreted diſtinctly from the body of the Root, and from the Fibre; and having not been formed when the Fibre was produced, it is not, nor can be continued from it into the Root.

THUS is formed, in the Seedling ANEMONE, an abſolute and perfect Vegetable, before there is the leaſt growth of a Stalk: and if it be ſo in all Plants, as I have found it to be in many, they talked wildly who have ſaid they ſaw the perfect future Herb in the Seed. The Plant is to be nouriſhed from the Root; and Nature has a great deal to do in the Root before it comes to that condition.

ALL this time a Root only is formed; with ſome faint approach toward Radical Leaves; and all the parts, even of the Root, are very tender, tho' the Microſcope can ſhew them thus diſtinctly. The growth has all been from one point; and that keeps its place at the anterior extremity of the Root: there the Microſcope ſhews the minute and duſky Rudiment of a Flower, incloſed in the Leaf which is to ſerve it hereafter, as a cup; and this is all. The Stalk is accidental, and a trifle; it has no place in the Rudiment;

Rudiment; but is a mere intermediate continuation of the ſeveral parts, or original ſubſtances, extended in length.

THREE years this little Rudiment is growing to perfection in the head of the new Root; and till the end of that time it can never be ſeen perfectly: nor till that time does Nature ſend it up above the ground.

IN the mean while a few ſlight and ſimple Leaves are formed. They riſe from the ſame Fleſhy Subſtance of the Root, which is the original of all the Plant; and their uſe is to draw nouriſhment from the air, and to aſſiſt the courſe and current of the Juices in the Root, where the young Flower is nurſing.

AT the appointed period riſes the Flower, ſupported by a Stalk, and covered by the Leaf, which ſerves it as a cup, till it is hardened enough to bear the air: then the Leaf expands, and leaves it free to blow, and gain its colour; and the Stalk riſes above its inſertion, to give the future Seeds more freely to the winds.

THE Rudiment of the Flower, while it remains at the Crown of the Root, is a continuation of the ſeveral ſubſtances of which the Root itſelf is formed. The Proceſs lengthens from the body of the Root at the other end, but this Crown remains unaltered: it is the future Flower, tho' very obſcure in all its parts. The Pith has its termination firſt in this Crown, breaking into many oval particles: which are to be the Rudiments of Seeds in the SINGLE ANEMONE, or the inner Petals in the DOUBLE.

THE Conic Cluſters form a little ſwelling at the Head of the Root; and next terminates the Fleſhy Subſtance of the Root, in a multitude of delicate ſlender Fibres. Theſe are to be the Filaments in the Single Flower; or the Fringe of the Double. The Vaſcular Series forms its thick Ring: and the Blea is terminated by the three broad Scales, which are to be the three inner Petals of the Flower. The next ſubſtance, counting from the Pith, is the inner Rind; and this terminates within the ſame Crown of the Bud in three more Scales, which are to be the three outer Petals. Laſt of all, the outer Rind forms a ſhaggy covering, which is, in time, to be the Leaf upon the Stalk.

THUS all the original and conſtituent parts of the Root are terminated at the Crown, in a Bud; and thus the imperfect Figure of a Flower is formed. All that is wanting is the effect of nouriſhment, and time; to fill and harden theſe ſhadowy reſemblances, into the real things they repreſent. As ſoon as that is done the Stalk is formed; and the force of the aſcending Sap ſhoots it upward. The ſeveral periods of its growth are repreſented at Figure 1, Letters a, b, c, d; and in Fig. 2, the entire and

perfect Plant is ſhewn diſſected. We ſee there the illuſtration at large of what we traced out in the Bud in little; and perceive diſtinctly how each portion of the original ſubſtance forms its part of the Flower; and in that terminates.

THE Leaves which riſe firſt, ſerve only to draw moiſture from the air, to evaporate the abundance of that received from the earth, and to keep up the courſe of a circulation in the Juices, while the Bud is forming. The Stalk, which afterwards ſupports the Flower, is raiſed originally from the Fleſh of the Root. It is covered with abſolute continuations of the Blea and Rinds, and is nothing more than a lengthening of that Neck by which the Rudiment of the Flower was firſt connected to the head of the Root; which Neck is no diſtinct ſubſtance, but only the place where the arch of Fleſh riſes from the Root; and the part where the ſeveral Coats become firſt attenuated for the formation of a Flower. The Flower is the enlarged Bud which crowned the head of the Proceſs; and the Stalk is the continued Root ſupporting it above ground: it is no way altered but in conſequence of that ſituation.

To trace the parts, and to aſcertain this ſyſtem, I have repreſented an entire Plant of the ANEMONE in flower, cut open, with its Root, even to the extream Fibres.

BEGINNING with that point at the Head or Crown of the Root where the original Vegetative Power reſided, the whole is thus performed.

THE Fleſhy Subſtance, which was the original point, now ſurrounds the Pith of the Root, in form of a greeniſh line, Fig. 2, *l l*; and from the part m, whence it began to grow when firſt formed, riſes a Proceſs or part of its ſurface, which forms the Fleſh of the Stalk of the Plant; the other way alſo from the ſame point runs the full Coat of Fleſh, following the form of the body of the Root obliquely downward. This Fleſhy Subſtance which ſurrounds the Pith of the Root, ſends portions of itſelf into the Fibres, covered with the proper Coats; and in theſe there is a Pith, but not continuous with that of the body of the Root. Theſe Fibres are of a vaſt length, and at their ends are very minute; but they are not open at the extremity, as has been thought. They are cloſed; and the ſeveral ſubſtances which compoſe them ſurround the Pith there, as they do elſewhere; but the whole Rind is ſpungy. That nouriſhment which was hitherto ſuppoſed to be drawn in at their extremities, is abſorbed by the whole ſurface. Thus I ſuſpect it is alſo with the Lymphatick Veſſels of Animals: indeed, I think, I have ſeen it.

AT

AT the Head of the Root, or from the original point upwards, ſhoots a Stalk. This ariſes abſolutely and ſolely from the Fleſhy Subſtance of the Root; not at all from the Pith, as has been ſuppoſed: and tho' this Rudiment of a Stalk be the original Vegetative Point in the Plant, yet we ſee all about it inſtances the moſt plain and obvious, that the ſame Fleſhy Subſtance is able, from any part or point whatever, to ſhoot up other Stalks. We ſee upon the Root the originations of ſeveral Buds of different growths, and containing the Rudiments of Flowers more or leſs advanced. All theſe riſe plainly alſo from the Fleſhy Subſtance; not from the Pith of the Root at all: they are ſeparated from it by a plain greeniſh line; which is the Fleſhy Subſtance in its whole body, and is carried between them and the Pith.

THE Stalk riſes in the ſame manner. The Fleſhy Subſtance of the Root ſends up a thin portion, which riſes immediately covered with its three Coats, the Blea, the inner, and the outer Rind, and forms preſently the Vaſcular Series, and the Conic Cluſters. Theſe run up uninterrupted from the Root into the Stalk: but the Pith of the Root does not, nor poſſibly can; for the body of the Stalk is not formed of the entire thickneſs of the Fleſhy Subſtance of the Root, but only of a part of it; and the remaining part ſurrounds that portion of the Pith in the ſame manner as all the reſt, ſeparating the center of the Stalk from the central ſubſtance of the Root entirely. Fig. 2, *n*.

THUS riſes the Stalk of the ANEMONE; and tho' it derives no Pith from the body of the Root, it quickly has one: for it is in the nature of the Fleſhy Subſtance, whereſoever it is lodged, to ſhoot the extremities of its Veſſels inward, and theſe form a Pith in the Stalk; juſt as thoſe of the original morſel formed that in the Root; and juſt as the Fleſhy Subſtance formed it in the Fibres. The Stalks and Fibres are conſtructed exactly alike in this reſpect: both have a Pith, not derived from the Root, but formed from themſelves; and diſtinct from the central ſubſtance of the Root; not only as being diſcontinuous, but as being looſer, and more ſpungy: diſtinct equally in place and ſubſtance.

IN the lower part of the Stalk the ſeveral Coats are white and delicate, ſo that it is hard to trace them diſtinctly, except before the moſt powerful Microſcopes; only the Pith is plainly ſeparated from the reſt, being looſer, and more ſpungy.

IN a ſecond ſection, taking that part which is juſt above the ground, they appear very diſtinct: the outer Rind is brown and tough, the inner Rind is purpliſh and ſpungy, but thinner than in the Root. Next comes

the Blea, which is white, and in conſiderable quantity; and within that the thin, green Vaſcular Series; then the Fleſhy Subſtance, which is green, and nearly equal to the Blea in thickneſs: Within this is the hollow of the Stalk filled with Pith, ſurrounded with the Conic Cluſters. All theſe parts may be ſeparated by maceration; and thus we are to follow them up the Plant.

THEY appear in this diſtinct form all the way up to the Leaf upon the Stalk, *o*, where the brown and tough exterior Bark ſhoots outward, expands, and forms that Leaf. It continues into it, terminates in it, and is there entirely loſt.

AT this joint of the Stalk there is, as it were, a new ſhoot made. The Stalk above this Leaf is not a continuation of the Stalk below; but a growth of a new one: juſt as that from the head of the Root. The Proceſs of Nature is the ſame in both; and one being underſtood the other is evident.

As the Stalk riſes to this part where the Leaf is placed, it grows thicker; but it grows alſo hollow, *p*. The Pith, ſuppoſed ſo eſſential to the Plant, is, in great part, obliterated here; and there ſeems an end of the Stalk: for the outer Rind is gone off in the Leaf, and the great Fleſhy Subſtance comes to a kind of termination, ſurrounding the top of the Stalk in this part, juſt as it did the Root at the Crown. There are three ſubſtances which ſurround this fleſhy part, the Vaſcular Series, the Blea, and the inner Rind: theſe do not come to a termination, but continue themſelves up into a new Stalk; juſt as the three Coats, theſe two and the outer Rind, did from the Crown of the Root. See Fig. 3, *a*.

THE Fleſhy Subſtance, tho' it ſeems to terminate there, does in reality ſend up a part of its thickneſs alſo, which lines them, *b*; from this ſhoots internally a Pith: and thus is formed a ſecond Stalk upon the head of the firſt; which has all its parts, except the outer Rind. It conſiſts of one Rind, a Blea, a Vaſcular Series, a Fleſhy Subſtance, the Conic Cluſters, and a Pith; and thus it is continued to the Flower.

WHEN we ſplit this upper Stalk, and trace it thither, we find the Fleſhy Subſtance runs up in an uninterrupted courſe to the head of the new Stalk; and its Pith forms the head of Seeds. The courſe is very ſingular and beautiful in this Plant; and it may be traced eaſily. The Fleſhy Subſtance runs up a little way into the baſe of the head; for the Filaments riſe thence; but as it runs out into theſe, it diminiſhes in ſubſtance till at about one third of the height of the head there is nothing of it left: all the reſt is made

made up of the abſolute Pith, and covered with Membranes formed only by its hardening Juices, Fig. 2, *k*.

If we begin at the inſertion of the Leaf, cutting the Flowerſtalk half thro', and gently ſeparating its ſeveral ſubſtances, we ſhall firſt take up a tough and firm Skin: this is the outer part of the preſent Stalk, and it was the ſecond or inner Rind in that below. It was there purple; it is here greeniſh: but it has ſtill ſomething of the original hue. If we draw a part of this off carefully to the head, we ſhall take off with it one of the three outer Petals. This Petal is a plain and evident continuation of its ſubſtance: as plain as the continuation of the outer Rind into the Leaf upon the Stalk. The formation of the Petal from the Rind, is this at the point of the Flowerſtalk which makes its ſummit, and where the Conic Cluſters form that ſmall head, the Receptacle of the Flower, this Rind of the Stalk ſwells into a kind of knot: juſt as the outer Bark did at the origination of the Leaf; and in this Knot or Gland, for ſuch it truly is, the Veſſels of the Rind which form it have many interweavings one with another, and ſwell out into little lumps. From theſe riſe the Veſſels of the Petal. But to underſtand this we muſt trace the matter yet deeper.

This ſecond Rind of the Stalk, which appears outermoſt in the part now under examination, is not a ſimple Film, but has, as that of the Hellebore, and other Plants, a regular and large arrangement of Veſſels. Theſe are connected by two Films, which are mere ſimple Membranes. In this form the Rind runs up to the head of the Stalk, where it makes a peculiar Gland, and is thence continued into a Petal. The Veſſels interweave with one another, without inoſculation, and make the body of the Gland: this ſeparates the two Films, which contained them in the common courſe of the Rind, to ſuch a diſtance that the three parts can be ſeen diſtinctly. The Films ſtill cover the Gland, as they did the Veſſels in the Rind, and they are continued upward into the two ſides of the Petal, Fig. 2, *f*, *g*. Thus one part of the Vegetable Syſtem ſerves to explain another; and the courſe of Nature being underſtood, is followed eaſily.

The body of the Petal is compoſed of three ſubſtances, a vaſcular part in the center forming a kind of Fleſh, and two Membranes, one on each ſide. The Rind itſelf is formed of the ſame parts, only they are more diſtinct in the Petal: and the uſe of the Gland is to give the ſubſtance of the Rind a kind of Root, full of nouriſhment, by means of which it may expand and form theſe Petals.

In this Gland alſo are ſecreted the Juices, which give the Flower its colour: for the Petal while young is green, juſt as the Rind from which it riſes: it has form firſt, and colour afterwards.

The three outer Petals being pulled off, and the whole Rind with them, the Blea of the Plant appears: this is continued up to the baſes of the inner Petals; and forms them juſt as the inner Bark did the others.

These being removed in the ſame manner, we have only the thick line round the baſe of the Receptacle, with the Fringe, and inner Petals of the doubleneſs left. There are three parts to form theſe; for there yet remains a Stalk, compoſed of the Fleſhy Subſtance, covered by the Vaſcular Series, tho' diveſted of three coverings, and lined with its Conic Cluſters, and its Pith.

If we ſeparate the thin Vaſcular Series, this brings away the thick line round the Receptacle: then taking the Fleſhy Subſtance from its lining, the Pith, we bring away the entire Fringe, i. The Conic Cluſters terminate in the Receptacle itſelf.

The Fleſhy Subſtance of the Stalk runs up to a ſmall height beyond the Petals, and there divides itſelf into the Filaments, which compoſe the Fringe. Its whole ſubſtance goes off into them. They are formed of bundles of its Veſſels covered with a Film, from their own extravaſated Juice. The part above theſe is the Receptacle of the Seeds, an oblong Bud, formed merely of the Conic Cluſters; and covered with a Skin of a ſpungy Subſtance, made from its drying Juices. On this reſt the Rudiments of Seeds, conſtituted of the Pith; which, in the double ſtate of the Plant, make the ſmall inner Petals.

This Plant being conſidered as a third Stage in the Vegetable Orders, may ſerve, after the inſtances of the firſt and ſecond in the Colchicum, and Aconite, to explain entirely the courſe of the Juices in Vegetables, and the manner of their growth; and a juſt conſideration of its Fabrick, after the knowledge of the more ſimple ſtructure of thoſe other two, will, I perſuade myſelf, ſhew the truth of that ſyſtem here propoſed, which adopting, and uniting the two formerly received, eſtabliſhes the growth of Plants upon the force of a Circulation of their moſt eſſential Juices; and their Nouriſhment and general OEconomy, in a great meaſure, upon that Evaporation and Abſorption by their Leaves, which has been ſuppoſed to ſet aſide the other.

In all Plants a watery nouriſhment is received continually by the Roots; and during the night by their Leaves. The part of this proper for the increaſe of the Plant is ſecreted, and after two or three concoctions, delivered

Anemone.

ed to that eſſential part the Fleſh of the Root: and after this the ſyſtem of Evaporation ſerves the excellent purpoſe of diſcharging that moiſture which had been drained off its uſeful parts, and making room for more.

THUS is a continual ſupply of freſh moiſture received; and from it, by peculiar ſecretions, that part is ſeparated which can increaſe the bulk of the Plant: This part is delivered to the Fleſh, whoſe Veſſels all returning upon themſelves, it is carried round, in a circulatory motion. The diſtention and contraction of the Fleſh, and other parts, from the various degrees of heat in the Atmoſphere, giving the motion; and the Valves in the Fleſh-Veſſels, which open only one way, directing the courſe. From the Fleſh are ſent the Conic Cluſters of Veſſels into all parts of the Plant, which alſo give that kind of ſecondary Circulation we have named; and from the abundance of Juice in the Fleſh, thus fed by the Roots and Leaves, riſes a portion which forms a Stalk. In the moſt ſimple kinds, as COLCHICUM, even this intermediate part is wanting; in the ACONITE it riſes a few inches, and then breaks into a Flower, where the Rudiment of new Plants are formed; but in the ANEMONE, the Flower being raiſed higher, there is a ſecond growth of Stalk, the part above the Leaf riſing from the arch of the Fleſh at that Joint, juſt as the lower part did from the Root. Thus is a more complex Vegetable Body nouriſhed by two circulatory ſyſtems, as a more ſimple one was by one ſuch ſyſtem; and it is eaſy to ſee from this, that in order to ſupport the largeſt and moſt complex of all, there can require only ſo many more repetitions of the original circulatory ſyſtem.

THEY erred who fancied a Circulation in all the parts of Plants; for the uſe of the exterior Coats is merely Abſorption and Evaporation; but I muſt be allowed to ſay, ſince theſe plain facts confirm it, that neither were they right who thought Abſorption and Evaporation gave growth to the eſſential parts of Vegetables. The Circulatory Syſtem lies deep, and has not been obſerved: the attention of the Curious being fixed on one point, drew their followers from the other. It is certain, that without that great operation the Evaporation by means of the Leaves and other parts open to the air, the Juices of the circulatory ſyſtem could not be fed; for the ſame exhauſted moiſture would remain in the Plant: but, on the other hand, it is equally certain, that a vegetable body may be kept alive without the aſſiſtance of that operation. This is ſeen in thoſe tuburous and bulbous Roots which, for many months, have no Leaf, or other part above the ground, yet continue alive and healthy; and are ready, upon a change of the ſtate of the air and earth, by heat and moiſture, to

ſhoot

ſhoot up of themſelves thoſe parts in which Evaporation and Abſorption are to be performed; and thence to grow.

THERE is ſomething in this article more than has yet been obſerved: it is not alone for a few months in the natural way of growth, that a Root will thus remain alive in the ground without any Shoot above the ſurface. What Nature in her proper courſe ordains in theſe inſtances, accident, or art, may effect in a much more ſurprizing manner. Roots will remain alive, and in full vigour, ſeveral years, from various accidents, yet without ſending up any Shoot; and will afterwards afford Plants not only as perfect, but much ſtronger and finer than they would have done in the common courſe of things. This dormant ſtate of Roots demands, and deſerves the attention of all who purſue theſe ſtudies. The fact is certain.

THERE is now in the collection of that great Patron and Ornament of the Botanic Science, the DUKE OF ARGYLE, a Root of the CANARY CAMPANULA, which is as full of health and vegetative life as a Root can be, and yet has made no Shoot for a whole year; yet there is no cauſe to doubt that it will hereafter ſhoot a perfect Stalk. This is not limitted to the Exotick Plants. I have known, by a peculiar accident, a Root of POLYPODY, on the ſtump of an old beech, live without any ſhooting up a Leaf five years, and afterwards, from a change in the condition of the place, grow with an uncommon vigour, with large indented, and almoſt laciniated Leaves. Much more might be ſaid on this head, but the ſubject is yet new, and I would excite, and not anticipate the reſearches of others, on a point which promiſes to be replete with wonder.

CHAP. XXXVIII.

Of Extraordinary COURSES of the JUICES of PLANTS.

NATURE is never traced more happily than in her irregular productions; but it requires to know her ordinary courſe firſt: the manner of her deviations prove the truth of thoſe original laws we have diſcovered, and give a new ſpecies of evidence, as convincing as it is ſtrange.

THE cloſe of the laſt Chapter gave an inſtance of Nature doing leſs than ſhe is wont in the ſame inſtances; and in the preſent we ſhall view her method when ſhe effects much more. The defect is a ſubject not yet ripe for explanation; but it is not difficult to ſee that it will probably enlighten and confirm the preſent ſyſtem: the exceſs is frequent, and has been

been long known, and often examined. The Luxuriant Leaves of Kitchen Garden Plants, the Curled Mallow, and the Daniſh Mint, and a multitude of others, afford inſtances of this exceſs in one kind, the Double and Proliferous Flowers in another; but the moſt ſingular of all, are thoſe which regard the Fruits of Plants.

THE Exceſs in point of Curled and Enlarged Leaves, depends entirely on the effect of an abundant moiſture in the ground, ſwelling the Blea, which makes their middle ſubſtance, and which, wherever it extends, carry the Membranes with it. As this is the conſequence of an extreme quantity of nouriſhment affecting that part, an extraordinary addition of thoſe ſubſtances to the Soil, which particularly ſtrengthen the Fleſh, cauſes Doubleneſs in the Flower, by expanding the Filaments into Petals, and often ſpliting them to increaſe the number; and thoſe Manures which ſtrengthen the Blea, without ſo great increaſe, in the ſame manner cauſe Proliferation, or the riſe of one Flower from the center of another, in the ſtead of Seeds.

THESE ſubjects I have had occaſion to examine ſeparately, in two peculiar Treatiſes, the Philoſophy of which, experiments have ſince repeatedly confirmed. The doctrine of Proliferous Fruits is a new ſubject: the Courſe of the Juices may be very ſtrongly illuſtrated by it, and the preſent year has afforded a very happy opportunity in the ſucceeding inſtance.

CHAP. XXXIX.

Of the PROLIFEROUS PINEAPPLE.

AMONG a number of PINEAPPLES raiſed two years ſince in the Iſland of ANTIGUA, there appeared one of an extraordinary ſize and form; covered, as well as crowned, by its new offspring. This was brought into England, preſerved in a kind of pickle and preſented to her Royal Highneſs the Princeſs Dowager of Wales, who is pleaſed to honour theſe ſtudies with her moſt gracious protection and regard. The Root, the height of Stem, and common circumſtances of growth were the ſam in this as in other Plants of its kind; but the fruit, was, in the higheſt degree, wonderful in its conſtruction.

IN the common PINEAPPLE the top of the Fruit is terminated by a Crown of Leaves, ariſing from a ſmall fleſhy Baſe; and this is properly a young Shoot, which needs only to be ſeparated, and planted to grow.

The

The ſurface of the Fruit, from the baſe of this Crown to the Stalk, is every where covered with Tubercles, within which are placed the Flowers and Seeds of the Plant. In this moſt ſingular ſubject many of the Tubercles of the Fruit grew out into ſo many little Crowns, each formed perfectly as the natural Crown at the top of a common PINEAPPLE; and all as fit for growth. The Tubercles on one ſide of the Fruit, for a ſmall ſpace, retained their natural form, while the whole circumference beſide was covered with theſe leſſer Crowns ſo cloſe, that they crowded one another. There were not leſs than ſeventy of thoſe new productions on the ſingle Fruit; and the whole appears to have enjoyed a ſtate of vigour and full growth at the time when it was cut, which ſeems to have been about ten days before it natural ripeneſs. A Figure of it entire is given in Plate XIII.

SINCE we know from this ſtrange effort of Nature, that the PINEAPPLE Fruit is capable of Proliferation in an extreme degree, it may not be impoſſible to turn the ſubject to account: for we know Proliferation in Flowers may be brought on by a peculiar management; and probably the ſame holds true of this: if it ſhould prove ſo, the increaſe would be many times greater than any other way. It may not be foreign to the purpoſe, to hint ſo much, as to the poſſible utility of the Proliferation of PINEAPPLES: but our immediate buſineſs here is to examine in what manner nature produced this moſt extraordinary offſpring.

I HAVE been permitted to cut the proliferous Fruit aſunder, to aſſiſt in this reſearch, and by compariſon of its conſtruction with that of the natural and common PINEAPPLE, I think the courſe by which theſe new Shoots were protruded may be found. The firſt Step toward this is, to know truly the ſtructure of the PINEAPPLE in its uſual ſtate; for in this there is ſomething very different from the formation of other Plants: That we may trace this from the firſt ſtage to the laſt, under our own ſight, it will be proper to ſelect a Plant raiſed from a Crown of a common PINEAPPLE. Its growth is this.

THE Crown of Leaves being twiſted off from a ripe PINEAPPLE, there comes out with them that Fleſhy Baſe before named, to which they are connected, and from which they grow. When it has been ſometime planted, Fibres are ſhot out from this Fleſhy Subſtance at the baſe, for ſeeking nouriſhment; and theſe, by degrees, grow to be ſo many Roots, of the thickneſs of a large Packthread, and of an extreme length. From their ſides alſo grow numerous branched Fibres. As we plant the Crown in Pots,

Proliferous Pineapple.

Pots, theſe Roots, when they have reached the bottom, turn up again, ſpread themſelves thro' the body of Mould, and run up to the ſurface.

THESE Fibres riſe in two, three, or more circles, round about the Fleſhy Baſe of the Crown; none from its bottom; that becomes callous, and is wholly uſeleſs to the growth.

IN this Baſe, and in the Fibres, equally, we may trace, by a careful examination, ſix of the ſeven conſtituent parts of Plants. The Pith alone is wanting: This is wanting entirely; and we have here a proof of the doctrine before eſtabliſhed, tho' it be contrary to the received opinions, namely, that the Pith is not an eſſential part of Plants; ſince here is one without it.

THE diſpoſition of the parts in the PINEAPPLE is not exactly as in other Plants, but is peculiarly adapted to the nature of the growth. Whether we examine a Fibre of the Root, the original baſe of the Crown, or the riſing Stalk, which is a continuation, or farther growth of that baſe, we ſee the ſame conſtruction: nay, we may trace it thro' the Fruit itſelf.

THE beſt part for examination is the Stalk. A thin ſlice of this laid before a ſufficient magnifying power, ſhews diſtinctly, 1. a thin colourleſs outer Bark; 2. a thick green inner Rind; 3. a thin Coat of pure Blea; this is of the colour and aſpect of a fine rich Jelly, a little tinged from the inner Rind. The Fleſh of the Plant follows but this is very ſingularly diſpoſed; it is not connected into a body, nor does it make a regular circle in the Stalk. We know the Fleſh in all Plants is vaſcular; and in this ſpecies the Veſſels are diſtinct. They are as thick as a ſmall Twine; yellowiſh in colour, and plainly hollow; and theſe with a large proportion of the Blea, make up the body of the Stalk. The two more delicate parts remaining are to be ſeen only with great magnifiers, for they are both minute. Upon the Coats of thoſe Veſſels which are neareſt the outer ſurface of the Stalk, runs the ſeparated Vaſcular Series; and on the inner ſurfaces of thoſe near the center, and thoſe only run the Conic Cluſters. The firſt are pale brown, the ſecond green; ſo their colour ſerves to diſtinguiſh them; the abſolute Fleſh Veſſels being yellowiſh.

IT may appear ſingular, that the Blea of the Stalk in this Plant takes the place of Pith, for ſo it does, mixing itſelf every where between and among the Fibres, and occupying even the center. But neither this diſpoſition of that part, nor its quality, will ſurprize us, when by tracing the courſe farther, we find this Blea is deſtined to make the Pulp of the Fruit.

IF we ſplit the new-planted Crown of a PINEAPPLE ſoon after it has begun to grow, we ſhall find the Fleſhy Lump within, beginning to lengthen

then into a Stalk; and very ſoon the Rudiment of another Fruit is ſeen upon its top, and on the head of this, its own ſmall Crown. Thus is the propagation of this Plant a moſt clear inſtance of what has been before aſſerted, that all Vegetable increaſe, however the term Generation may have been applied to it in ſome inſtances, is nothing more than a continued growth.

If we next ſplit down a half-grown PINEAPPLE with its Stalk, we ſee its conſtruction yet more diſtinctly; and may trace, with eaſe, the origination of the Fruit. A PINEAPPLE in this ſtate ſplit thro' the center with its Stalk, is repreſented Plate XIV. Fig. 2. The two Rinds, *a b*, make the ſurface of the Stalk; within theſe runs up a pure Coat of Blea, *c*; and in the midſt are ſeen the Fleſh Veſſels, *d d*, intermixed with more of the Blea.

In this ſection we ſee clearly, that the PINEAPPLE is not ſo properly a Fruit fixed upon a Stalk, as a Stalk ſwelling into a Fruit. To find how this is done, our attention muſt be directed to the part *e e*, Fig. 2, where the Stalk ends and the Fruit begins. Here we ſee plainly enough the continuations of the ſeveral parts. The outer Rind thickens, and gives origin to thoſe ſmall Films, or imperfect Leaves *f f f f*, which riſe under the Tubercles; the inner Rind, *b b*, forms the Coat of the Tubercles, under which the Blea, *c c*, ſwells and expands into the body of the Fruit. A great quantity of it is ſent up to this part, where it ſwells and ſtretches out the Stalk into a kind of oval form, and ripening, becomes the delicate Pulp of the Fruit, *g g*. All this while the Fleſh Veſſels, *d d*, with their concomitant leſſer vaſcular ſyſtems run up ſtrait thro' the center of the Fruit, not ſeparating to any greater diſtance, but forming the ſame kind of looſe column they did in the Stalk itſelf. The extenſion of the Blea is marked with the Letters *g g*, in Fig. 2, and the plain courſe of the Veſſels running up its center, at *b b*, there is no difference between the Fleſh Veſſels of the Fruit and thoſe of the Stalk, except that in the Fruit they are ſmaller and more numerous, having divided at the part *e e*, and ſent off a few very delicate portions ſideways and obliquely upwards, *i i*, which are to give origin to the Filaments within the Flowers lodged in the Tubercles, *k k*.

This is the ſtructure of the Fruit of the PINEAPPLE, whoſe ſmall Flowers are formed within thoſe Tubercles, of all the parts, as in other Plants. But in the mean time that eſſential ſubſtance the Fleſh of the Plant, which has continued its ſtrait and upright courſe thro' the Fruit, when it has reached the ſummit forms a new ſolid Subſtance, the Part *l*, which is the Rudiment of a new Plant, and from which riſes the Crown of

of Leaves. This terminates the growth; and this being ready to take Root, and grow again, Nature, in a manner, trifles with the Flowers, and is little ſolicitous about Seeds.

THE little maſs of Fleſh is formed where the Fleſh-Veſſels terminate at the head of the Fruit, is the moſt eſſential part of the Plant, the Seat of Life of the ſucceeding Offspring, and the point from which all is to grow. We are intereſted therefore to underſtand this diſtinctly. It is thus formed. When the Fleſh-Veſſels have arrived at this, their extream growth, they prepare to return upon themſelves: At the point *e*, the baſe of the Fruit, each divided into ſeveral ſmaller; but at the ſummit, *l*, they again divide into almoſt innumerable and extremely minute threads. The Coats of theſe, which are very tender, ſuffer a part of their Juice to ouze out: this part is white, like Cream, and it ſoon thickens. The fine Fleſh-Veſſels having returned in arches at the ſummit of the part *l*, marked *m*, return in an elliptick form, as in the globules of Farina of other Plants, to the baſe of that part, *n*, and there, while ſome run down, the greater part inoſculate with one another. The Juice they have extravaſated, forms a thick fleſhy matter between them, and a great deal of the ſame white Juice being extravaſated at the part *o*, where the Fleſh-Veſſels begin to divide thus minutely, this ſpreads itſelf round the Fleſhy Lump already formed, making it a thick white Coat: and thus the baſe of the PINEAPPLE Crown is finiſhed. The growth of Leaves is natural when nouriſhment is continued; for this baſe being compoſed of the Fleſh of the Plant, can produce all the other Parts; and the two Rinds, which its extravaſated Juices form, make thoſe Leaves.

THIS is the ſtructure of the PINEAPPLE in its natural ſtate; and from what we have ſeen of the Vegetable Nature it is plain this Crown, when committed to the ground, muſt grow. This Fleſhy Lump has the ſame Conſtruction with a Globule of Farina, only it is more largely formed. The elliptick Rings are larger by many degrees, and there are vaſt numbers of them. The white Juice which thickens between the Fleſh-Veſſels, and round them, is the rich Blea of a new Plant; and the two Coats are given it by the hardening of its own Juices in the Air; as they are given to all other Plants. Therefore this Fleſhy Lump is the natural original of a new Plant, which has ſhot its crown of Leaves while it remains upon the parent Stalk, as the original elliptick Ring of the Farina in other Plants does its Seed-Leaves; and like that, when committed properly to the earth, it is ready to grow.

THIS conſtruction of the common PINEAPPLE will be ſeen diſtinctly in the ſection Fig. 2; and this being underſtood, the Proliferation of the ſingular Plant here deſcribed, which to an untaught mind would ſeem ſo wonderful, may be moſt clearly explained.

WHEREVER the Fleſh-Veſſels of this Plant form, by their termination, a Fleſhy Lump, as that at *l*, there is the original of a new Plant: the extravaſated Juices of thoſe Veſſels form a Blea, and the two Rinds are given this by the air, as in all other caſes.

IN the natural and common ſtate of the PINEAPPLE, the whole Body of Fleſh-Veſſels runs up to the Summit of the Fruit; and only a few very minute Branches from them are ſent off ſideways toward the Tubercles, for forming the Filaments of the Flower. But if luxuriant nouriſhment, or any other favouring Accident, cauſe the Fleſh-Veſſels to be ſo ſtrong in Vigour that theſe ſide Branches, naturally minute, become enlarged, and are like thoſe of the middle Column, then they will terminate at the Surface, not in their own peculiar Manner, as Filaments, but in the ſame way as thoſe of the middle Column: that is, there will be formed at the extremity of each Cluſter, ſuch a fleſhy maſs as that at the Letter *l*, in Fig. 2; and from this Leaves will grow. It will terminate the Fleſh-Veſſels of the old Plant in their natural way: that is, it will give the origination of a new one; which will obtain its Crown of Leaves while it remains upon the parent Stock; and when removed from it, will be ready to grow. The Terminations of theſe Cluſters of enlarged Branches from the Column of Fleſh Veſſels, muſt be at the Tubercles of the Fruit; becauſe thoſe Branches are directed only thither; conſequently, it is within a Tubercle only each of theſe fleſhy terminations muſt be formed.

WE thus ſee from Reaſon, the neceſſity of what appeared ſo ſtrange in this great Fruit: for if any cauſe could enlarge thoſe Branches of the Fleſh-Veſſels which go to the Tubercles, in the natural ſtate of the Plant, they muſt, inſtead of Filaments in a Fower, form new originations of Plants in thoſe Tubercles: theſe muſt have their firſt growth on the Plant; that firſt growth is a Crown of Leaves, and conſequently, each Tubercle to which ſuch a quantity of enlarged Branches went, muſt, inſtead of containing an inconſiderable Flower, burſt into a full Crown.

THE ſection of the Proliferous Fruit at Plate XIV. Fig. 1, which is exactly done from Nature, is a plain illuſtration of this ſyſtem: and very happily a part of the Tubercles of this curious Specimen, having retained their original and natural condition, we ſee this alteration moſt diſtinctly.

IN

Sections of Pineapples.

In the ſplit Stalk, at Letter *a*, we ſee the Fleſh-Veſſels, large and few in number, purſuing their plain courſe up the Stalk: at the baſe of the Fruit, *b*, they divide; and in the Column, *c*, which runs up the middle of the Fruit, they are ſmaller, and more numerous.

Luxuriant Nouriſhment having been afforded them, at the point *d*, this Column ſplits; and inſtead of one Crown, the natural termination of a Pineapple Fruit, there are formed two of thoſe fleſhy baſes, *e f*, and theſe ſending out Leaves, as uſual, there are two Crowns formed in the place of one.

On one ſide this middle Column of Fleſh-Veſſels has ſent out a number of Cluſters of ſmall Branches, as is uſual, and theſe keep their natural courſe and proper ſize; and run to the Tubercles for which they are deſtined, in a right form for conſtituting Filaments in the intended Flowers of the Plant: theſe Tubercles therefore keep their natural form; and even, on the other ſide, there are two or three Cluſters, *h h*, which hold the ſame unaltered condition, and therefore terminate at natural Tubercles: but for the moſt part on this ſide the figure; and thro' the greater part of the body of the Fruit, we ſee thoſe Cluſters of Branches from the central column of Fleſh-Veſſels, which ſhould have held the minute condition of thoſe at *g g*, and *h h*, in Fig. 1; and of all thoſe, *i i*, in Fig. 2. enlarged to a degree in which they are no longer Cluſters of Ramifications, but ſo many Columns of full Veſſels, as at *i i i i i*, Fig. 1. like in dimenſions, and in form, to the natural central Column in the Fruit. As they are like thoſe in their nature, they muſt terminate as they do; not in Filaments, but in proper Crowns. This is the termination we ſee they have at *k k k*, and thus the Pineapple becomes Proliferous.

CHAP. XL.

Of the External Form and Parts of Plants.

HAVING now gone thro' the conſideration of the inner ſtructure of Vegetable Bodies, the courſe of their Juices, and their manner of growth, we may rationally proceed to take a general and particular view of the ſeveral parts which are formed and fed by thoſe Veſſels, and that courſe of Juice. According to theſe the whole Vegetable Kingdom is arranged, firſt into ſeven great families; and afterwards into the leſſer diſtributions of Claſſes, Orders, Genera, and Species. As the knowledge of the

the inner conſtruction of Plants was neceſſary to the eſtabliſhing a true notion of the origination and uſes of their external parts; in the ſame manner, a juſt ſenſe of the differences of thoſe parts themſelves, is needful to the underſtanding the characters of thoſe primary diviſions into Families, which are natural, and to which all others are ſubordinate, we ſhall therefore firſt enter into a detail of thoſe external parts, and from thence proceed to the Characters of theſe ſeven arrangements.

THE general and obvious parts of Plants are four: the Root, the Stalk, the Leaves, the Flower; but there are others very important in their nature and office, tho' they were leſs regarded in the earlier times of Botany, theſe the great SWEDE firſt brought to the World's eye; and upon theſe he has founded often his Specifick, and ſometimes his Generical Diſtinctions. Many of them had not been obſerved till he diſcovered them; and others, tho' they could not but be obvious, were ſo perfectly ſlighted in the accounts of Plants, that they wanted even names. Theſe we ſhall enumerate, and diſtinguiſh here, under the conſideration of the Parts of Plants: their utility in Syſtems will be ſhewn hereafter.

IN conſidering the Parts of Plants, Reaſon directs us firſt to the Root; becauſe it is the part firſt formed from the Seed, and is the ſource of all the reſt.

THE Root of a Plant is a Caſe or Shell of the Fleſhy Subſtance, lined with a Pith, and covered with a Blea, and two Rinds; and is naturally buried under the ground. Immediately within this Shell of Fleſh run the Conic Cluſters of Veſſels, which conſtitute the Ribs of the ſucceeding Leaves; and cloſe upon its ſurface creep the Vaſcular Series, ſecreting that waxy matter which coats the Embryo in the Farina of the Flower. This is a ROOT whatever be its form; whether long or ſhort, tuberous or fibrous, perpendicular or horizontal: but Bulbs do not come under this denomination; they are of various kinds, and different nature; the coated Bulbs are Buds, the ſolid are Placentæ; there is always a Root beſide.

THE office of the Root is to produce all the other parts of the Plant, by extenſions of that Fleſhy Shell, which is its eſſential part. This forms by Proceſſes from its ſurface Fibres downwards, and Stalks upward. It firſt nouriſhes the Seminal or Radical Leaves, by food drawn in at its Fibres; and is afterwards itſelf in part nouriſhed by thoſe Leaves it had produced; and fed ſo, that it is able to raiſe the Stalk for Flowering, and producing of new Embryo Plants.

THE

THE RADICAL LEAVES of Plants are thoſe which riſe immediately from the Root, with their own Footſtalks; which have no connection with the Flowering Stalk of the Plant, but precede it in order of time; ſerve for its firſt growth, ſupport and nouriſhment, till it has Leaves of its own; and then decay, and periſh utterly.

THESE Leaves are always compoſed of three ſubſtances; a Rind, a Blea, and Cluſters of Veſſels. Sometimes they have alſo an outer Bark over the Rind, but not always. The Rind of their Footſtalk is a continuation of the inner Rind of the Root, which expanding over the Leaves themſelves, becomes a common Membrane: when they have an outer Rind, that alſo is produced ſimply by a continuation from the outer Bark of the Root. The Blea of theſe Leaves is alſo ſimply continued from the Blea of the Root: and the Veſſels riſe from thoſe of the Conic Cluſters of the Root; tho' not by plain continuation, but by a peculiar kind of vaſcular Baſe.

THE office of theſe Leaves is to evaporate during the day a great part of that Moiſture which the Roots draw from the ground, after its nouriſhing Juices have been ſeparated by the ſeveral Glands; and in the cool of evening, and during night, to receive from the air a quantity of moiſture replete with the like nouriſhment for the Plant, which is to be ſecreted in the ſame manner. They ſerve alſo to keep up a perfect communication between the Root and riſing Stalk; for the Veſſels which form their Ribs, are ſent from the Conic Cluſters of the Root, which communicate with the Fleſhy Shell from whence the new Stalk riſes; and they return again into it. This is a fact which has not been enough known. No Veſſel of the Leaf terminates in the Leaf; they all run back into the Footſtalk, and purſue their courſe to its Baſe, returning there upon themſelves again. This forms what we have called a ſecondary ſyſtem of Circulation, dependant on that primary one in the Fleſh.

SEED Leaves agree with Radical Leaves in this Structure: it has been ſhewn in the courſe of the Veſſels of the Seed Leaves of the Radiſh, and may be ſeen diſtinctly in the Radical Leaves of the generality of Plants. In thoſe of the BLOODY DOCK, this return, and the inoſculations of the Veſſels, are very evident, becauſe the Ribs are thick, and highly coloured: but of all Plants the COLOCASIA ſhews it moſt diſtinctly. In the Radical Leaves of that Plant, the main middle Rib, and the ſeveral ſide Branches, terminate in a large purple line, which runs round the whole circumference of the Leaf; and in the middle ſpace between each pair of ſide Ribs, runs a delicate returning Veſſel: this takes its origin from the Cord which ſurrounds the Leaf, and empties itſelf by innumerable Branches, into

into the ſide and middle Ribs again. The Circulation of Blood, and Inoſculation of the Veſſels in animal bodies, before a Microſcope, are not more palpable, or diſtinct, than thoſe of the Veſſels of this Leaf to the naked eye. If any doubts the ſyſtem here eſtabliſhed, let him read in that Plant its confirmation. We are not to ſuppoſe that the Juice from theſe returning Veſſels is thrown into the ſame Veſſels which contain the aſcending part; that would create confuſion. Each ſide Rib is compoſed of Veſſels; ſome of which carry up the Juice to that Cord ſurrounding the Leaf, and others receive it returning from thoſe inoſculations. Nature ſcarce affords an object more beautiful.

THE STALK OF A PLANT is a tubular portion of the Fleſh of the Root, lined with its own Pith and Conic Cluſters, and coated with its Vaſcular Series, Blea, and two Rinds. It raiſes the Flower into the free air, and gives the ſucceeding Seeds to its power to ſcatter.

THIS is a kind of Root above ground, nouriſhed, indeed, from the Root below, but like that producing all the external parts of a Vegetable Body. It has Leaves, whoſe origin, ſtructure, and office, are the ſame with thoſe from the Root; and it terminates in a Flower; its ſeveral parts dividing, and, when ſeparated from one another, forming the organs of the Flower, the embryo Plant in the Farina, and the defending Seed.

THE Stalk gives place and origin alſo to ſeveral of thoſe parts, to which the new Botany has adapted names, and which it has received into the number of ſpecifick Diſtinctions. The moſt conſiderable are thoſe Spines which arm the ſurface of many Shrubs and Plants. Theſe are of two kinds, and have diſtinct names according to the conſtituent part of the Plant from whence they take their origin. When the Spine ariſes from the Wood, it is called SPINA; when from the Bark, ACULEUS. We may in our language keep up the diſtinction, calling that which is fixed to the wood a THORN, and that which riſes from the Bark, a PRICKLE.

THE HAIRS of Plants are next to be conſidered as appendages of the Stalk; tho' common alſo to the Leaves, in many Plants: theſe when they are permanent, afford marks of diſtinction. Their office is to diſcharge abundant moiſture, when the nouriſhing Juice has been ſecreted from it.

FROM the Stalk alſo riſe in many Plants a peculiar kind of thin ſubſtances ſurrounding the baſes of the Footſtalks of the Leaves. We ſee theſe in the Roſe buſh, and in Peaſe: They are different and diſtinct from Leaves, tho' in ſome few inſtances they ſupply the place of them; as in the APHACA, or YELLOW VETCH. The Term for theſe is STIPULÆ; we may call them FILMS.

FROM

FROM the upper part of the Stalk, in ſome Plants, there riſe alſo a kind of thin ſubſtances of the nature of the former, but accompanying the Flowers, as thoſe attend the Leaves: the Latin term for theſe is BRACTEÆ; we may call them FLORAL LEAVES or SCALES.

TENDRILLS are another appendage of the Stalks of certain Plants. Theſe are fine ſlender twiſted Filaments, which tye the Plant, as it were, to ſome adjoining ſubſtance. They generally are found upon thoſe Plants which have Stems too weak to ſupport themſelves, and yet too firm for twiſting round Trees, or other bodies.

FINALLY, among the adjuncts of the Stalk are to be named thoſe GLANDS which, in ſome Plants, are large and obvious. Theſe are of various form, but they have only one office, which is to ſeparate and diſcharge the redundance of that nouriſhment which has been ſent to the part where they are placed. Theſe grow ſometimes on the main Stalk of the Plant, ſometimes on the Footſtalk of the Leaf, and in ſome Plants on the Leaves themſelves.

IF to theſe parts we add the Buds of Trees, and of Perennial Plants, we have all that the new Botany has adopted as diſtinctive parts, on this foundation. Theſe Buds are ſo many ſmall Proceſſes of the Fleſh of the Plant; formed, as has been ſhewn in the aſcendant Shoot of the Hellebore Root, and in the Buds of the Anemone; covered with Films and Scales, or with imperfect Rudiments of Leaves, and ready, when the ſeaſon calls, to grow out into entire Plants.

THE FLOWERS of Plants, are the termination of their growth, and the ſeats of a new progeny. They are uſually diſtinguiſhed by a gaudy colour; but not always. There are four conſpicuous parts of which they conſiſt when perfect, but one or other of theſe is often wanting. The four natural and conſpicuous parts are, a Cup, the Leaves of the Flower, which we call Petals, the Filaments, with their Antheræ or Buttons, and the Rudiments of the Seeds, naked or under cover of a Fruit or Seed-Veſſel. Beſide theſe three are two other parts of a Flower leſs regarded; theſe are 1. a ſmall head crowning the Stalk, and giving riſe to the Petals or the Filaments, and called the Receptacle; 2. a thick Ring ſurrounding the baſe of this Receptacle, or placed near it, ſometimes riſing into peculiar bodies called Nectaria.

THESE are all the parts which we find in the moſt perfect Flowers; but in many kinds ſome of them are wanting: only the Filaments or Antheræ are found in all. Theſe are eſſential to the Flower, becauſe they contain thoſe Rudiments of new Plants for the defence and ſupport of which

the reſt were formed; therefore no purpoſe would be anſwered without them. In ſeveral Flowers the Cup is wanting, and in many the Petals; in ſome the Receptacle is not diſtinguiſhable; and the Nectaria are obvious but in a very few: the Antheræ or Buttons, naturally crowning theſe Filaments, are found in all; and the Rudiments of Seeds uſually in the ſame Flower, tho' ſometimes removed to another part of the ſame Plant; and in ſome ſpecies to another individual.

THE Origination of theſe ſeveral parts has been diſtinctly ſhewn in the Plants already deſcribed, and it is the ſame in all. The Cup is the termination of the outer Bark; and conſequently thoſe Plants which have no outer Bark to the Stalk, can have no Cup to the Flower: The Petals are uſually diſpoſed in two ſeries, and are diſtinct in their nature; tho' this has not been enough obſerved. It has been ſhewn here in the Hellebore; and it is univerſal in the Vegetable Nature, tho' not in all Plants ſo obvious. Of theſe two ſeries of Petals, the outer are formed by the termination of the inner Rind of the Plant; the inner of the extremity of the Blea. Where theſe parts are wanting in a Flower, it is not that the inner Rind and Blea are wanting in the Stalk, for there is no Flowering Stalk without them. But they decay in thoſe Plants, where their growth ceaſes, and do not expand into theſe parts of the Flower.

THE Ring which ſurrounds the Receptacle, and which in the Hellebore and Aconite riſes into peculiar Nectaria, is the termination of the Vaſcular Series of the Stalk; and the Receptacle itſelf is formed of the extremities of the white Veſſels of the Conic Cluſters: between theſe riſe the originations of the Filaments; theſe being the extreme terminations of the Fleſh of the Plant: and the Pith forms the Rudiments of Seeds.

THESE are the Parts of Flowers, and theſe their ſeveral Originations. Their office we have ſhewn diſtinctly, in treating of the firſt growth of Herbs: and thus a detail of the external parts, their origin, and office, has given a Recapitulation of the Syſtem of Vegetable Nature. This diſtinct account of them will alſo have a farther uſe: it leads us to the firſt great arrangement of Plants into ſeven Families; and as the diſtinctions of theſe, one from another, are founded on the diſpoſition, peculiarities, or deficiencies of thoſe Parts, we ſhall hence underſtand their ſeparate Characters.

CHAP.

CHAP XLI.

Of the SEVEN VEGETABLE FAMILIES.

THE knowledge of particular Plants can no way be ſo perfectly obtained as by tracing the very origin of their diſtinctions in their ſtructure: he muſt firſt know what Vegetables are, as Vegetables, who would underſtand the particular ſubjects diſtinctly. Claſſical diſtributions, eſtabliſhed without this foundation, have been therefore vague; and have inſulted Nature: uniting what ſhe had ſeparated by large diviſions, and ſeparating what ſhe had intimately joined. Hence, perhaps, it is, that among ſo many good and uſeful methods as have been eſtabliſhed, there is not one natural. Hence TOURNEFORT ſeparated the Annual and Perennial ADONIS; and hence LINNÆUS joined in one Claſs the Violet and Marygold, forced to it by his artificial Characters, tho' ſenſible it was repugnant utterly to Nature.

PERHAPS upon the foundation of a true Anatomy of Plants, a natural method may be eſtabliſhed: for it is certain the forms of all the external parts depend on the diſpoſition of the internal; and all their differences are founded there. On the different inner ſtructure of the Vegetable Body under certain courſes of its Veſſels, evidently depend the differences which characterize the ſeven firſt Families; to the diſtinctions of which all Claſſes are ſubordinate; and as theſe original diſtinctions are truly natural, we may begin there ſafely.

THE ſeven Families are theſe. 1. The MUSHROOMS. 2. The ALGÆ, or Foleacious Sea and Land Plants. 3. The MOSSES. 4. The FERNS. 5. The GRASSES. 6. The PALMS. 7. The common Race of Plants. Their diſtinctions one from another are theſe.

1. THE MUSHROOMS are FLESHY; and are deſtitute of Leaves and viſible Flowers.

2. THE ALGÆ are merely FOLIACEOUS, the entire Plant conſiſting of a leafy matter, without other viſible parts.

3. THE Mosses have Proceſſes of the inner Rind for Leaves.

4. THE FERNS conſiſt of a ſingle Leaf raiſed on a Stalk; and bear their Flowers upon its Back.

5. THE GRASSES have jointed Stalks and undivided Leaves, and Huſks to hold the Seeds.

6. THE PALMS have a ſimple Trunk, with Leaves only on the Top, and have the Flowers and Fruit in divided Ears.

7. THE common Race of Plants are ſuch as thoſe we have deſcribed in the preceding Chapters, which have their Roots, Leaves, Stalks, Flowers, and Fruits diſtinct and obvious; and have not the Characters of any of the ſix other Families. Theſe Plants of the common kind have been the ſubjects of the preceding part of this work; it remains that we here enter upon the Characters and diſtinctions of the other ſix: and as the order wherein theſe are placed tends to lead us from the moſt ſimple of all gradually to the more complex, it will be moſt proper to ſelect from that ſimpleſt Claſs the MUSHROOMS, the kind which is moſt ſimple of all, the TRUFFLE. The Conſtruction of this Plant has not yet been well underſtood: and the Reader will, perhaps, be ſurprized to hear, that, plain and rude as it appears, it has all the eſſential parts of the moſt perfect Plants. This will appear upon a juſt enquiry; and no inſtance can more ſtrongly prove the general law wherewith we opened the way to theſe enquiries, that there is a certain ſtructure, peculiar to Vegetables, which conſtitutes them what they are, and gives them a right to the place they hold among the ranks of Beings; and that this is found in all Vegetables, thoſe which are called the moſt imperfect not excepted.

CHAP. XLII.

Of the TRUFFLE.

THE TRUFFLE, having no ſpecious parts, no Leaves, no Flowers, has been of old ſuppoſed to want alſo Seeds; and, with the Worms of putrefying ſubſtances, was long attributed to the equivocal Generation. Yet very early there were ſome thought otherwiſe; and later obſervations have gone farther toward aſcertaining its Hiſtory.

THE TRUFFLE has evident Seeds; but they are contained within its ſubſtance, under the Rind, and in the abſolute Fleſh. This is not ſingular to the Truffle; it has always been referred to the Muſhroom Claſs, and many, perhaps all the genuine Muſhrooms, have the Seeds covered. They are minute, and they require defence: they have, indeed, more occaſion for it than merely from their ſmallneſs. The young Plant is, in a manner, formed within them, by that time they have their bigneſs: and it would periſh if not well defended till their ſlight ſurface were tolerably hardened.

It is for this reaſon Nature has given the protection of a defence to them all, lodging them within the body of the Plant, or covering them with Membranes. In the common Muſhrooms, whoſe Seeds have been ſaid to lie naked on the Gills, ſome have them placed in cluſters, others ſingly: in the former kind I have always found them covered with a Membrane; and the latter, tho' it be leſs diſtinct, I think they have it. In the Boleti there is a ſpungy Membrane, which lines every Tube, and within this the Seeds are generated, breaking thro' it only as they ſwell. This is ſtrange, becauſe in both theſe inſtances the Male Flowers ſtand naked at a diſtance on the verge of the Tube, or the very edge of the Gill: but the delicate Farina of theſe eaſily pierces the natural openings in thoſe Membranes, and then the Seeds ſwelling burſt them. In the Hydnum they are covered with a kind of Tube, which is only a more delicate Membrane. In the Phallus, which approaches more to the Truffle, they are buried in a tough ſubſtance, which covers the head, and are only ſeen when it melts in decay, and becomes a liquor. In the Clathrus, ſtill nearer the Truffle, they are lodged in the very central ſubſtance which fills the cavity of that Net in the original ſtate. In the Elvela they lie under a very evident Membrane on the ſurface, which originally forms the upper Coat of the Plant, and which being pierced by their innumerable heads when they ripen, dries away, and lets them out in duſt. In the Peziza they are abſolute Fruits, in which the Seeds lie covered perfectly. In the Clavaria the Seeds are formed under the upper Coat, as in the Elvela. And in the Lycoperdon, to which the lateſt ſyſtems join the Tuber, the Seeds are contained in the abſolute ſubſtance of the Plant, which is originally encloſed within three firm Rinds, and is itſelf of a tough conſiſtence: but as the Seeds ripen, this intermediate matter dries away into thin Films and Fibres; and leaves them in a fine powder, free to the air.

These are the eſtabliſhed Genera of the Muſhroom kind; for they err greatly who refer the Plants which make mouldineſs to the ſame name. In all theſe the Seeds are covered in the Plant; in the Phallus and Lycoperdon, they are abſolutely contained in a Fleſhy Subſtance.

It is thus Nature has lodged them in the Truffle, which is the moſt fleſhy of all the Muſhrooms, and its conſtruction is this.

We ſee a round, or nearly round ball, whoſe ſurface is compoſed of a kind of points, each compoſed of four parts, and divided by four ridges raiſed above the Skin, and placed like rays of a Star: 1, 2. It is evident to ſight, in the freſh-cut Truffle, that this Bark is diſtinct from the Fleſh

Fleſh of the Plant; but it is difficult to ſeparate it, without heat and long maceration.

If ſome TRUFFLES be cut into ſlices, and ſtewed in river water, there riſes to the ſurface a peculiar matter, which, as it cools, forms a tough Skin like Vellum. This was originally a Juice lodged between the outer and ſecond Rind, and it held them faſt together. When the boiled TRUFFLE is diveſted of this, let it be macerated eighteen or twenty days in water, and the parts will ſeparate. We then take off a brown outer Rind, which is rough, unequal in its texture, and very thin. This does not form, but merely covers the Tubercles on the ſurface. 3, 4.

Under this we find a yellowiſh Coat, conſiderably thicker, 7, 8; but neither does this form the Tubercles: it, like the other, only covers them. The Ridges are plain in this, 9, 10; and the true form of the Tubercle is better ſeen here than in the other: at the Head is a little opening; and there is the ſame in the outer Rind, on the Head of each Tubercle, only its naturally uneven ſurface renders it more difficult to be diſtinguiſhed.

Between the brown and yellow Rind lies the tough, gluey matter which formed the Skin ſeparated in boiling, and which, till ſeparated, held them ſo faſt together.

The body of the TRUFFLE being thus cleared from its two Rinds, is of the ſame form that it was while they were upon it; it now appears a maſs of whitiſh Jelly, riſing into ſo many angulated Tubercles, 11: and, when cut aſunder, there is the appearance of another Coat; but this is a deception. There ſeems a Coat of a very conſiderable ſubſtance riſing into theſe Tubercles, and of ſome ſmall thickneſs, even in the ſpaces between them, covering a brown fleſhy matter. 12.

This is no more than an appearance. The whole white ſubſtance is the pure Pulp or Fleſh of the TRUFFLE; and it is this which abſolutely forms the Tubercles. In theſe, and for ſome ſmall thickneſs between them, and below them, it runs in the ſame pure form; and is diſtinguiſhed by its white colour: all within this is brown. This difference of colour, great as it appears, is owing to innumerable Seeds. The colour of theſe is a duſky brown; and they lie ſo cloſe, that they give the ſame hue to the whole inner part, when the naked eye only ſees it.

In a thin piece laid before the Microſcope, Fig. 13, we ſee the ſuperficial part is white, becauſe it is pure, unmixed with Seeds, and of a cloſer texture; and within it is of the ſame matter, white as that, but more ſpungy, and intermingled with theſe innumerable Seeds. It is the ſame difference that we ſee between the ſolid Pulp at the bottom of the Puff-

ball

ball Lycoperdon, and that looſer part of it above, which is intermixed with Seeds. The difference is the place, very little more.

THIS white ſubſtance of the TRUFFLE is ſpungy, and very like the ſpungy ends of the Hellebore Fibres; it would take nouriſhment at every Pore; but that would be too much; therefore Nature has given it this double Bark, lined between with a ſubſtance impenetrable to water, and indiſſoluble in it, as appears by its floating ſeparate and entire in boiling; and has left only a certain proportion of its ſurface open at the Head of every Tubercle. There, and there only, the white Fleſh or Blea of the TRUFFLE is naked, and there only it draws nouriſhment.

WE ſee thus what are the Coats, and what is the Fleſh or Subſtance of the TRUFFLE, how they are connected, and how they are diſpoſed. There remain the Seeds to be conſidered, and their Receptacles. For they erred who, having ſeen Seeds in the TRUFFLE, thought they were laid looſe in this Fleſhy Subſtance.

THE body of the TRUFFLE, within the circle of pure Fleſh, is compoſed of one great Veſſel, abſolutely continuous, but folded, and, as it were, divided into a multitude of oblong and irregular parts. There are fifty, ſixty, or more of theſe in one TRUFFLE; they lie cloſe in the center, and they run out toward the ſurface in all parts, Fig. 14: they terminate in obtuſe ends, at a ſmall diſtance within the ſurface; the white and pure Fleſh always covering them. Theſe parts of the great Seed-Veſſel are all full of Seeds; and the Membranes are ſo ſtrong, that they keep them ſecurely in their places. It is therefore the pure Fleſh is always white, and has none of them among it; it is, indeed, impoſſible it ſhould in the perfect ſtate of the Plant, for the Membranes abſolutely envelop them.

BY long and careful maceration we may diſſolve this Pulp or Fleſh entirely off, and leave the Veſſel naked. This might lead us to call it a Coat; but that it is continued to the center: it not only covers, but ſeparates the Lobes of the great Seed-Veſſel; and it is this which makes the marbling of the TRUFFLE. All we ſee brown is this prodigious and variouſly convoluted Seed-Veſſel. The white Lines that run among it are ſo many portions of the Fleſhy Subſtance, continued from the outer circle of it, and running whereſoever the convolutions of the Seed-Veſſel give it way: This is therefore not a Coat, but a peculiar matter, ſerving, as the Root; for it gives all the nouriſhment. Long boiling burſts the Veſſel, and ſwelling the lines of pulp between it, lets looſe the Seeds among that matter. Fig. 15.

WE

We have ſeen the Veſſel cleared of all the matter, and we are now to examine its ſtructure. This is very ſimple; it is compoſed of two Membranes; both pellucid; but the outer one the thickeſt. Fig. 16. The inner Membrane riſes into little Blebs, like round Bladders, at ſmall diſtances from one another, and theſe are properly the Seed-Veſſels of the TRUFFLE. Fig. 17. Four Seeds are lodged in each, 18: when we ſee a ſmaller number, it is owing to the Knife cutting the Veſſel in two.

EACH Seed is really a TRUFFLE. We ſee them at firſt ſmall, round, and ſmooth, and they appear no more than Particles of the outer Membrane of the great Veſſel, raiſed and looſened within the Bleb made by the riſing of the inner Skin, Fig. 19: as the TRUFFLE grows toward ripeneſs they enlarge, grow duſky, and rough, 20; and in the end, while they are yet in the body of the TRUFFLE, they acquire even their brown outer Coat; and they are TRUFFLES; wanting only growth.

THUS we ſee the courſe of Nature in the formation of the TRUFFLE. The outer Membrane of the great Veſſel is the eſſential part, analogous to the Fleſhy Subſtance in larger Plants. This has its three Coats, the two Rinds, and the Fleſh anſwering the Blea; and this inner Membrane in the place of Pith, from which, indeed, there run Fibrils, making a true tho' very light Pith in the Lobes and between the Seeds.

IN all Vegetables the eſſential part, or ſubſtance, ſends off at its extremity Particles, which being lodged in the Seed, are capable of growth into new Plants. In this plain Vegetable, the TRUFFLE, there is nothing of the apparatus of Filaments, and the other parts of a Flower. But Particles of the eſſential part, which is the outer Membrane of the great Veſſel, ſeparate themſelves, and are defended by a little Bleb of the raiſed inner Membrane. Here they float in a clear liquor, and they immediately grow. They are at firſt only round pieces of the Membrane itſelf; but this forms all its own Coats, as the Particle in the Seeds of Plants does; and by cutting TRUFFLES at various periods of ripeneſs, we may even ſee this done. Firſt the Fleſh, or pure Pulp, is formed, and the little Seed then is ſomewhat larger, and more opake. After this the yellowiſh Rind is formed, and it is then more opake, and ſomewhat coloured, Fig. 21: and, finally, the outer Bark is alſo formed; it is then obſcure and rough, Fig. 22. It is a perfect TRUFFLE, and requires only to ENCREASE in ſize to be what its parent was.

ALTHO' the Seeds of the TRUFFLE are thus extreamly numerous, and to the Microſcope very plain and diſtinct, nothing is more difficult than to get them clear of the Veſſel, and ſeparate for examination. The Reaſon is

is, that the Bleb wherein they are contained, as in a Seed-Veſſel, is part of the inner Membrane of the great Veſſel itſelf, and that Membrane is no where ſtronger than in the place of their connection. Maceration anſwers the purpoſe of ſeparation on all common occaſions, but the whole ſubſtance of the TRUFFLE is tough, and remains a long time unaltered in water.

WITH great difficulty, after very long maceration of extreamly thin ſlices of the TRUFFLE, they may be thus ſeparated imperfectly. Lay a thin macerated ſlice on a Plate of Glaſs before the Microſcope: firſt waſh it ſeveral times in clean water, and then lay on it a large drop of filtred water. This care is needful, that no ſmall bodies may be accidentally on the Glaſs. Then obſerve with the Microſcope where the edge of the piece is broken and moſt ragged: lay the Glaſs upon white Paper, and with a Camel's-hair Pencil very gently rub and ſweep, as it were, that part, carrying the ſhort ſtrokes outward. On laying it before the Microſcope again, there will be ſeen ſome ſeparated Seeds; but they will not float looſe, the Bleb or Film wherein the few are contained, as in a Capſule, comes off entire. Thus, however, we have them ſeparate from the Plant. We ſee this Capſule now diſtinctly: It is a delicate, colourleſs, tranſparent Membrane, and is a little inclining to oval: at the ſmaller end there is a plain Neck, by which it was originally faſtened to the Membrane whence it roſe; and the Coat is, in this part, lacerated. The Seeds lie regularly in this Capſule, with a ſmall opening between them in the center, and a great deal of ſpace outwardly.

WHEN we have ſufficiently examined theſe Seeds in their Capſules, the way to get ſome of them looſe is this: in a drop of the ſame kind of water, lay another very thin piece of the macerated TRUFFLE; obſerve the thinneſt edge of this, and with a ſmall Pencil of Hog's-briſtles ſtamp upon the TRUFFLE in the water, and by this means a great many of the Seed-Veſſels will be looſened, ſome of which the ends of the Briſtles will have burſt, and the Seeds will then be viſible diſtinctly, for many will get out of them, and float looſe in the water.

To ſee the Progreſſion of the Seeds in growth, we ſhould take the TRUFFLE in three ſtates for this experiment: the firſt when it is full of very young Seeds; the ſecond when they are half grown; and the third, when entire. Theſe were the obſervations I made on them.

IN thoſe TRUFFLES which have the Seed very young, the Bleb which holds them is ſmall; and each Seed, when ſeen ſeparate, is a roundiſh

pellucid Lump, only thicker in one part, where it originally grew to the outer Membrane. Fig. 19.

IN thoſe which have the Seed advancing toward ripeneſs, it is leſs clear than before, and begins to ſhew ſome degree of roughneſs in the Coat. Fig. 20, 21.

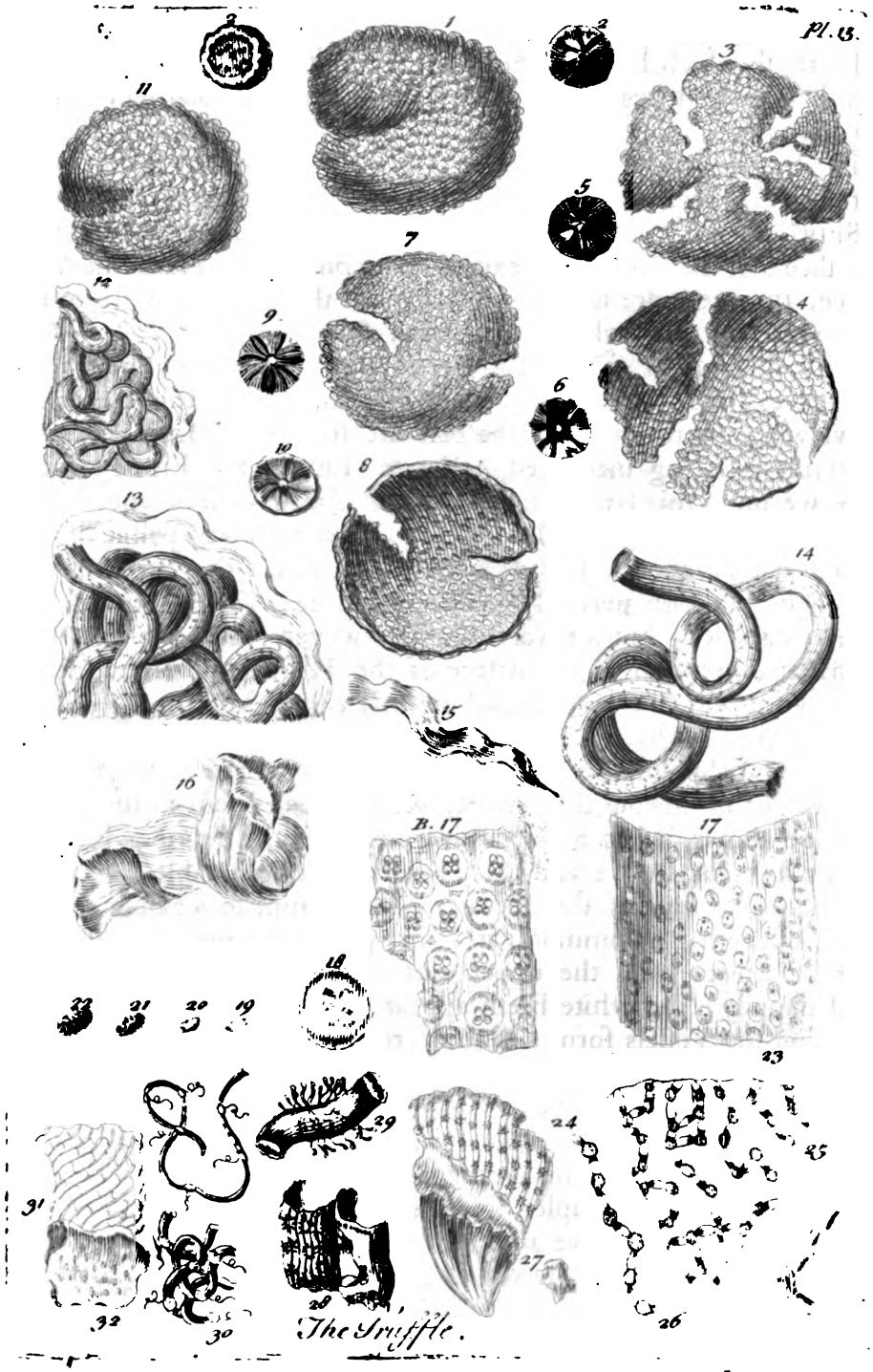
IN the perfectly ripe, the whole ſurface is covered with Tubercles, as in the entire TRUFFLE, only they are longer and ſlenderer. Fig. 22.

SPIRIT of Wine, even by long ſteeping, makes no change in the thinneſt ſlices of the TRUFFLE, except that contracting and hardening the ſubſtance, the Seeds are ſeen leſs diſtinctly in the ſlices, and are more difficult to be ſeparated than when in the maceration.

THE outer Bark of the TRUFFLE is brittle beyond almoſt all Vegetable Subſtances: it is therefore extremely difficult to get thin pieces of it pure for viewing the ſtructure. The beſt are to be had from the angles of a Tubercle in a long macerated half-ripe TRUFFLE. Fig. 23. Examining theſe we find, this Bark is compoſed of jointed Veſſels, and loaded with a brown coarſe ſubſtance. The Veſſels are themſelves pellucid, and appear ſo between the ſeveral Joints; but at thoſe places they ſwell out into more thickneſs, and are perfectly opake. Fig. 24. They do not run in any regular direction, but are variouſly interwoven with one another, and go in that manner all over the ſurface of the TRUFFLE; uniting themſelves at every Joint with the inner Rind, by many little Mouths. Fig. 25.

THIS ſhews why this Bark is ſo extremely brittle. The Veſſels are very tender, and the Joints are loaded with a heavy matter: therefore the force and weight in moving theſe alone, would break them in the intervals; but they are alſo joined ſo firmly at every Knot with the inner Rind, that they muſt alſo break there; and theſe Knots are innumerable. For this reaſon, in whatſoever ſtate of the TRUFFLE we attempt to ſeparate its outer Rind, unleſs with very uncommon care, that part comes off in little ſcraps. The view of a piece from the upper part of a Tubercle, ſhews the ſtructure moſt happily: the white Fleſh appears naked in the aperture at the ſummit, and the Veſſels form a kind of regular Fringe on the edge round it, running clear from the white ſubſtance, in a kind of rays.

THE inner Rind of the TRUFFLE may be ſeparated ſowewhat better from the Fleſh, but ſtill with great difficulty, tho' from another cauſe. When we have a very thin piece of this clean before the Microſcope, we find it compoſed of ſimpler, plainer, and leſs entangled Veſſels than the other. We may perceive alſo, that theſe are contained between two Membranes, and buried, as it were, in a vaſt quantity of ſpungy Pulp. They are



The Truffle.

are innumerable in the minuteſt piece of the Rind; their Coats are rough, their Cavities very ſmall; and their Surface, at intervals, is fringed juſt in the manner of the middle part of the Fibres of Black Hellebore Root. Fig. 27. This Fringe plainly conſiſts of Fibrils; and theſe piercing the Joints of the Veſſels of the outer Rind, at their innumerable mouths, make the ſtrict union there is of thoſe two ſubſtances. Fig. 28.

THESE parts are all very ſmall in the TRUFFLE, as are alſo its Seeds; but when ſought with care, they are found diſtinctly. The inner Rind, even in very thin pieces, appears ſpungy, dark, and coarſe; but in many trials made on the well macerated parts, ſome Veſſels will appear diſtinctly. This Rind of the TRUFFLE does not preſerve ſo exact a thickneſs in all parts, or terminate ſo equally round about the Fleſh, as in the more regular Plants. It runs into that ſubſtance in many places, and is alway terminated by a waved and very irregular out-line. And I have obſerved diſtinctly, that thoſe Veſſels which run neareſt the Fleſh, have the ſame Fibrils at certain diſtances, as the others.

THE Fleſh of the TRUFFLE, tho' it takes the place of the Blea in Plants and Trees, has not its proper nature. In that part there are in other Plants, clear Cells, and coloured Sap-Veſſels; but in the TRUFFLE it conſiſts of Veſſels only; theſe are, indeed, lodged in a white ſpungy ſubſtance, ſuch as is found in the interſtices of Veſſels in other parts; but this is not formed into regular Cells, nor is it of any determinate Figure; it ſerves only to lodge the Veſſels and to prevent their preſſing upon one another. Theſe Veſſels are perfectly tranſparent, and they are jointed as the others, but at greater diſtances.

FROM the Joints of theſe run various curled and twiſted, milk-white Fibrils in all parts where they touch the Membrane, and in no other part. There are alſo innumerable orifices on the ſurfaces of theſe Veſſels throughout, by which they communicate with the extreme parts.

WITHIN this Fleſh of the TRUFFLE is contained that great and moſt ſurprizing part, the Membranous Veſſel, in which are lodged the Seeds. This is conſiderably thick, and perfectly pellucid. In moſt views it appears no other than a piece of an extreme thin Bladder; but with great Magnifiers we ſee Veſſels in it; and they are numerous. They run upon its inner ſurface, and are fixed down to it; and the Membrane which lines it is their other Covering. Theſe are the eſſential Veſſels of the Plant; and I doubt not but pieces of this Membrane, cut off in any part, would grow.

THIS Membrane may be moſt diſtinctly ſeen in a piece from which, after due maceration, the Seeds have been wiped away in water, with a

Camel's-hair Pencil. The parts where each Bleb, or Seed-Veſſel adhered, appear a little rough; Fig. 32. For the reſt, the Membrane is tranſparent, and is not ſeen, unleſs in diſtinction from the more elevated Veſſels; and the little Specks, or Rudiments of future Blebs for Seeds.

THE inner Membrane is a mere Film; it only lines the other, and forms the Blebs or Seed-Veſſels. The Seeds of the TRUFFLE, tho' very diſtinct to powerful Glaſſes, are too minute for the management of the Gardener's hand in ſowing. Probably they ſwell greatly when the TRUFFLE burſts with ripeneſs: for the Seeds of moſt Muſhrooms do ſo. Thoſe of the Lamellated kinds increaſe to ſixty or ſeventy times their bigneſs, after they are fallen from the Plant, before they begin to burſt for the growth of the included Muſhroom.

CHAP. XLIII.

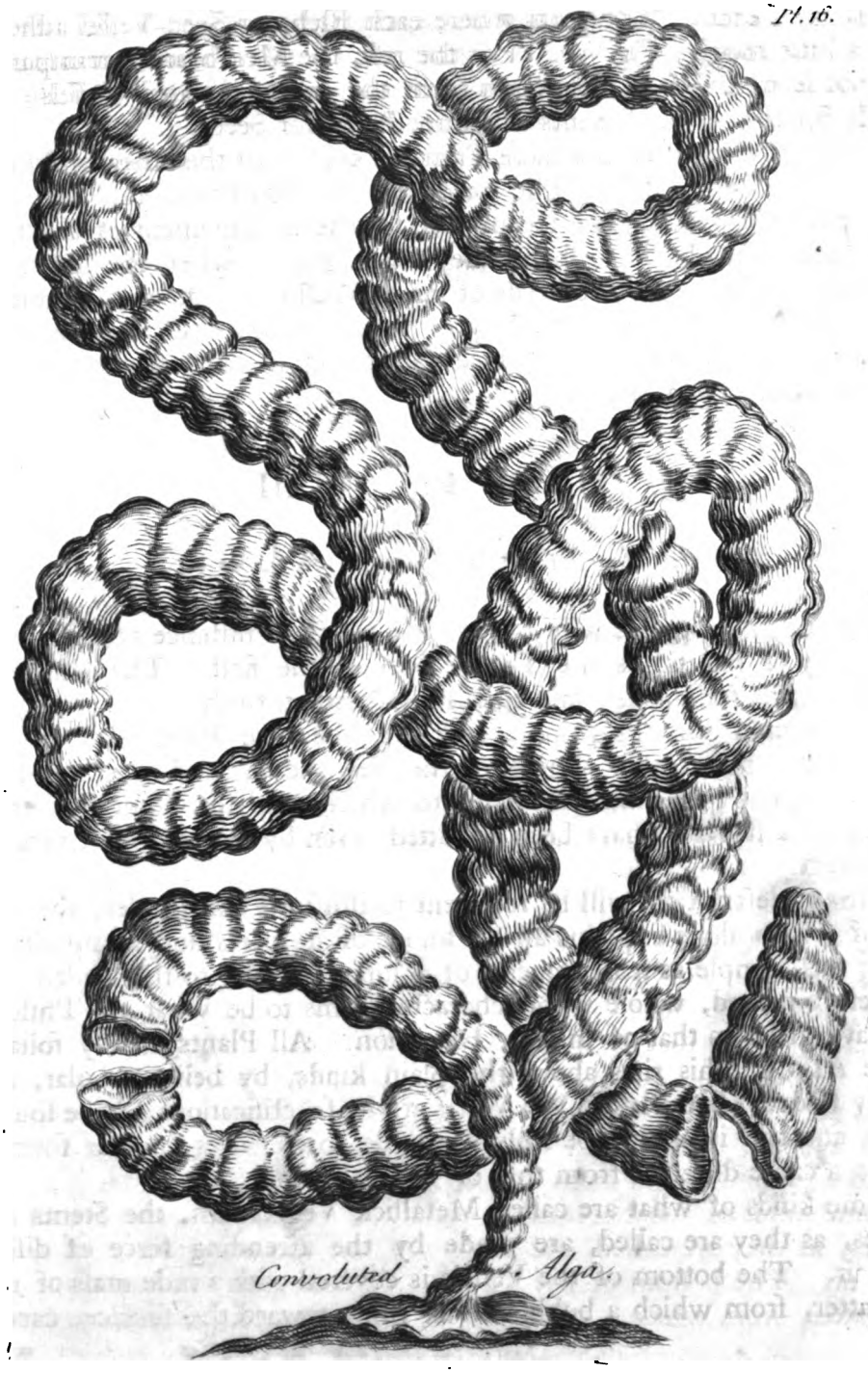
Of the CONVOLUTED ALGA.

THIS ſingular Species will give us as diſtinct an inſtance of the ſecond Family of Plants, as the Truffle does of the firſt. The Character of theſe is to be foliaceous; and this is foliaceous entirely.

THE common OISTERGREEN, and the like, are Plants alſo of this claſs; and it is from thoſe natives of the Sea the term ALGA has been taken, to expreſs the entire Family: into which, perhaps, ſome Plants of too complex a ſtructure have been admitted, even by Writers eſteemed the moſt correct.

A SHORT deſcription will be ſufficient to illuſtrate this ſpecies, the very figure of which alone explains all we know of its parts and compoſition: yet even this, ſimple as it is, appears of a ſuperior order to thoſe plain flat kinds before named, whoſe whole character ſeems to be what the Philoſophers have given as that of matter, Extenſion. All Plants merely foliaceous, are ALGÆ; this riſes above the plain kinds, by being tubular, and elegantly folded. See Plate XV. What are its fructifications I have ſought in vain: and tho' its matter be truly vegetable, perhaps its ſingular form is owing to a cauſe different from that of Vegetation.

IN ſome kinds of what are called Metallick Vegetations, the Stems and Branches, as they are called, are made by the aſcending force of diſentangled air. The bottom of the Veſſels is covered with a rude maſs of mineral matter, from which a bubble of air riſing toward the ſurface, carries with



Convoluted Alga.

with it all the way, a thin coat of that mass, which hardening in the liquor, appears long and hollow, and is called a Branch. In a manner somewhat like this the bottoms of the Ditches in our Salt Marshes, are covered with a light, and flat foliaceous green substance, which spreads evenly upon the mud. This is plainly the original of the Convoluted ALGA; and, perhaps, in this, not in the more specious upright form, we may sometime find the Seeds of the Plant.

A BUBBLE of the air, imprisoned between this green Coat and the Mud, may rise toward the surface; and as the Coat is tough and flexible, this Bubble may ascend cloathed with it, as in the other instance: the motion of the Water may give the Convolutions, as this gives the hollowness; and from these combined Powers may arise the peculiar form, not of this alone, but of many of the Confervæ, which are also of this Family; and which, perhaps, have hitherto imposed upon the world as processes of vegetative growth.

THE Curious will receive this as conjecture: it is proposed no otherwise: but if succeeding seasons should shew to me, or others, the Fructifications of this Plant in its simpler part, upon the bottom of the Waters, this opinion will be strengthened; and, perhaps, extended to more instances.

THIS Convoluted ALGA which, from its place of growth, and its resemblance of prepared Animal Intestines, the common class of Writers have called the Sea Chitterling, ascends without a Stalk, as it grows from no Root: where there is one of these parts, there naturally is the other; because they depend upon, and are continuations, in great part, of one another. The surface of the plain Plate rises in a Tube, and ascends to two, three, or four feet in height: it is naturally upright; but it is so weak, that the force of the water bends down its top; which rising again, and being again bent by the same force, twists the whole Tube about, in a manner, tho' more loose, yet something like what Nature shews in the disposition of the Intestines in an animal body. The surface also, by the same impression, is crushed a little, as it continues to grow; and these pressures, so often repeated, force down the new part of the Tube upon itself, at short intervals, and by that means make the indentings, swellings, ribs, and furrows, which shew their light traces lengthwise, and transversely throughout the body of the Plant.

THE Tube maintains all the way a large cavity; and as the air has great space in it for expansion, it does not burst at top; but terminates in an entire plain and closed end.

THO'

THO' it originally riſes from a continued Coat of the ſame matter at the bottom of the Ditch, its bigneſs gives the water ſo much power upon it, when moved by the Wind or Tide, that it is ſoon torn off, and floats looſe. In this ſtate it lives as perfectly as while there was a communication between it and the plain Coat at the bottom; and floats about all Summer.

CHAP. XLIV.

Of the SWAN'S NECK BRYUM.

IN this inſtance of the third natural Family of Plants, I have been obliged to have recourſe to a new Character of Diſtinction; ſince thoſe formerly eſtabliſhed are, if not erroneous, at leaſt equivocal. LINNÆUS ſuppoſes the heads we ſee on this, and the like Moſſes, to be Antheræ, and the powder they contain a true Farina; and that the naked Seeds are lodged on other parts of the Plants. On this foundation he eſtabliſhes the Character of the MOSSES to be an Anthera without a Filament, and remote from the Female Flower. To me it had appeared, long before, that the Head in theſe MOSSES is truly and properly a Seed-Veſſel; and its Corona, a part little underſtood, or even regarded by others, I perſuaded myſelf, from various examinations, contained a true Farina.

THIS ſyſtem I laid before the Royal Society about twelve years ago; and they were pleaſed to do me the honour of printing it in their Tranſactions. Since that time one of the Linnæan School has endeavoured to revive the ſyſtem of his maſter; and what he has done on the ſubject, appeared among the Amænitates Exoticæ. The inſtance I ſelected in that paper of the Tranſactions, I think, was a Hypnum, one of the common MOSSES which bear heads; and that by which I am about to ſupport the ſame opinion here, is a BRYUM, one of a kind yet more common.

THE Linnæan ſyſtem is ſupported by a Plant of a very ſingular kind, unlike the reſt in its Fructifications, and perhaps, indeed, not properly a Moss. The ſubject is yet undetermined: the Reader will do me the juſtice to believe nothing could induce me to depart from the opinions of ſo reſpectable an Author, but what appeared to me the certain evidences of Nature. Theſe I am about to lay before him; and till this matter ſhall be decided, as I could not adopt the Linnæan Characters of this Family which appear to me erroneous; neither have I ventured to deduce a new one

one from my own. But as there is in the reſt of the Plant a ſufficient diſtinction, the inner Rind extending itſelf ſingly in the place of Leaves, a Character which ſo far as I have ſeen, is peculiar to the MOSSES among all Vegetable Nature, I have fixed the mark of the Family there.

THE ſpecies which is here ſelected for the illuſtration of this Family, is one of the moſt common: the ſpecimens uſed in the preſent enquiry were gathered from the low wall round the Reſervoir in Hyde Park. It grows only facing the North and North-Eaſt: To the Eaſt, tho' the wall is wetter, there is none; nor to any other quarter.

THE Tufts are large; but each Globule is a diſtinct Plant: It flowers and decays. Be the Tuft ever ſo big, there are no other Plants in it but ſuch as have heads in them for this ſeaſon, or on the decayed remains of laſt. They entangle by their Fibres, but do not riſe in Suckers.

THE Seed of February ripens in April, and is ſhed. Young Plants appear in October, and flower the February following. We ſee them on ſeparate ſpots, but moſt are near one another. The Stalk riſes from the center of the Globe of Leaves. The Leaves, that is the whole Globe, decay when the Seed is ſhed; ſo the old Plants appear deeper rooted in the Tuft than the others.

THE Seeds are light and tender: the greater part is loſt; but thoſe which fall upon the Tuft naturally ſucceed; for they have defence and moiſture. The old Plants from which the Capſule roſe, by degrees decay; and the Seeds which were at firſt lodged among them, ſwelled with moiſture, and ready to ſtrike, ſhoot out their Roots, and grow into Plants for the ſucceeding ſeaſon.

WE ſee this Moss uſually in roundiſh, or long Tufts, rooted in the mortar between the bricks of an old wall. Each tuft is compoſed of a multitude of Plants: We find theſe, tho' diſtinct at the head, yet entangled ſtrangely by the Roots. The whole Tuft, at this ſeaſon, conſiſts of Plants in three ſtates; ſome very conſpicuous, being in their perfection; others, which require more examination to diſcover them, being leſs grown; and others in decay. The perfect Plants have a long Stalk riſing from the center of the Globule, and crowned with its proper Head. Plate XVII. Fig. 1, x x x. The younger Plants conſiſt of a green Globule, with a Head in the center; the top of whoſe Calyptra, or Cover, only appears, y. The decayed Plants have ſometimes the remains of laſt year's Stalk, tho' uſually it is fallen out before this time; and the Tuft of Leaves is no longer globular, but ſpread open, z: all greatly magnified.

THE

THE Leaves form this globular body for the defence of the Rudiment of the Head, conſequently theſe are moſt compact before its Stalk is formed, and while it is yet entirely in their boſom: they are ſomewhat leſs folded over one another when the Stalk riſes; but when it has done its office, and is decayed, they ſeparate, and hang looſe.

IF we ſeparate a perfect Plant with care, at the time when it is in flower, we find it conſiſt of three parts. A ſlender and bending Stalk, ſupporting the flowering head; a globular or oval cluſter of Leaves growing round the baſe of that Stalk; and a long browniſh Root hung about with innumerable Fibres.

THE naked eye ſees no more; but few objects better deſerve a more ſtrict examination: the Microſcope ſhews this little BRYUM a magnificent as well as ſingular Plant: differing not only in fructification, but in the ſtructure of its parts, from all other Plants. See Plate XVII. Fig. 1.

THE Root is long, brown, and hung about with innumerable very long, and ſtrangely entangled Fibres, it is abrupt at the lower end, not attenuated; and in the part between that and the baſe of this cluſter of Leaves, mimicks a kind of Stem, but covered there alſo with the like Fibres, which riſe from every part of it. The length and number of theſe Fibres from the ſide and baſe of the Root, and their various entanglings, thoſe of one Root with thoſe of others, make it difficult to break the maſs; and often tye the ſeveral Plants ſo cloſely, that they ſeem to riſe in the way of Suckers from one another: But careful obſervation ſhews them to be really diſtinct; the ſeveral Roots uſually falling obliquely over one another. None are ſo eaſily ſeparated as the old decayed Plants of the laſt year, whoſe Fibres are by this time withered away.

FROM the ſummit of the Root riſe the Leaves which compoſe the Globe; and there are a few leſs perfect leafy Films between them.

THE Leaves which compoſe the Globe are ſix: the imperfect Films beneath them uſually two. Each Leaf is of an oval form, but terminated by a ſharp point, and they are hollowed. They reſemble very much the Leaves of ſome of the Aloes: their colour is a fine green, and their ſubſtance beautifully reticulated; not in the leaſt reſembling other Leaves.

THE Stalk riſes from the head of the Root, ſurrounded by theſe Leaves, and in the upper part twiſts itſelf into a kind of circle. It is very ſimple in its ſtructure; and at firſt green, but afterwards rediſh.

ON the top of this grows the Head; a part of very ſingular ſtructure.

IT is of an oval ſhape, ſwelled almoſt into roundneſs, and is covered by a membranaceous Hood, called the Calyptra: this is extended looſely over

the whole Head: it is gathered into a kind of Neck at the ſummit of the Stalk, and is continued beyond the extremity of the Head, in form of a beak, or long ſlender cylinder, is pierced at the top, and there riſes out of the aperture a fine crimſon body, oblong, and thickened at the end. Plate XVII. Fig. 1, *a a a.*

THIS is the ſtate of the Head when the Moss is in full flower. In a younger Plant it is ſlender, and appears longer, and the Calyptra has its hard brown Ring at the point of the Beak, and is open there; but there is nothing of the purple Filament. In the Seeding ſtate, the Head becomes yet more ſwelled, and the Calyptra being now not large enough to cover it, ſlips by degrees from the lower part, till at length it falls off. In this latter ſtate there is ſeen a faded remain of the Filament at the top of the Hood, and nothing more.

THO' the object be minute, it may with care be ſeparately examined. If the Skin forming the Hood be ſlit up, and drawn off entire, we ſee the naked Head, Fig. 1, *b b.* The Skin thus taken off is of the ſame reticular conſtitution with the Leaves; and it comes away entire with the cylindric Beak and purple Plume.

THE Head remains alſo entire, and is pear-ſhaped; ſmall at the inſertion, large at the other end, and is there terminated by a kind of Umbo, or low conic Button, Fig. 1. *c.* All this is perfectly green.

ON cutting the head longitudinally in half, ſee Fig. 2, its ſtructure is found to be this. The Stalk, at its ſummit, ſwells into a ſpungy thick lump, Fig. 2, a; and from the ſummit of this part, which is ſolid, it expands upwards, into that pear-like form we ſee, *b b*, which is hollow: the Shell, *c c*, is of conſiderable thickneſs; but the cavity, *d d*, is equal to many times the meaſure of the Shell. From the center of the Fleſhy lump, a, whoſe ſurface has ſwelled into this ſhell, riſes a Seed-Veſſel, *e e.* This is like a green cup, or drinking-glaſs, with a cover. The part which riſes immediately from the ſolid maſs, is a kind of Pedicle, *f f.* This expands into the body of the Seed-Veſſel, e; and the Cover is radiated, *g g.*

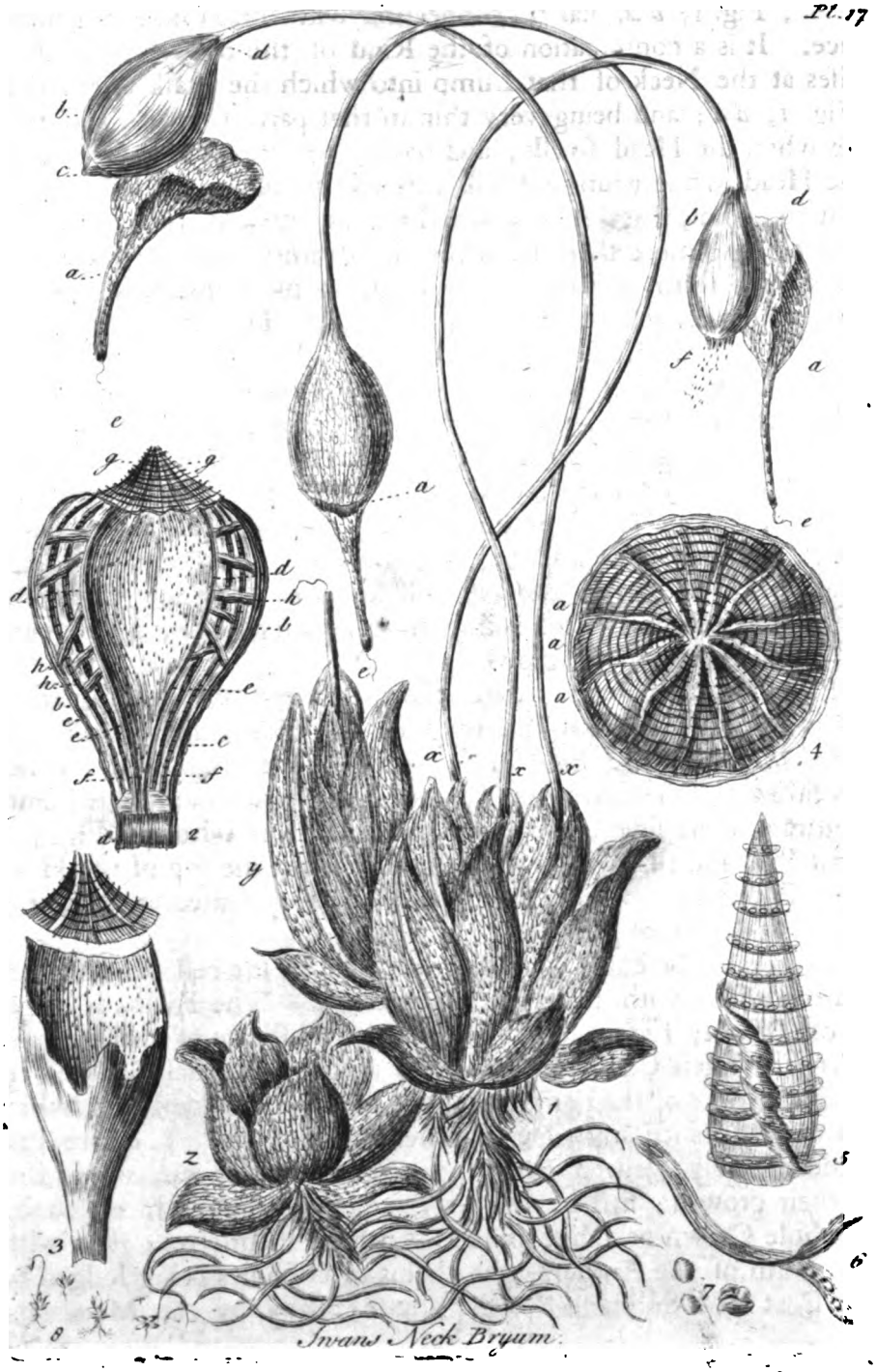
IT is eaſy to ſee this Seed-Veſſel is of great importance in the nature and œconomy of the Plant. It riſes in the center of the hollow Head, but does not nearly fill that cavity. There is a large ſpace every way round it; and it is kept in its place, and fed, by numerous thick Veſſels, *h h h*, which take their origin from the reticulated ſubſtance of the Shell, and are inſerted into the Seed-Veſſel. The Seed-Veſſel and Corona, ſeparated from the Head, are ſhewn at Fig. 3.

THE Hood, Fig. 1, *a a*, has no connection with the Head; it is merely a defence. It is a continuation of the Rind of the Stalk, and nothing elſe. It riſes at the Neck of that Lump into which the Stalk ſwells at its ſummit, Fig. 1, *d d*; and being very thin in that part, it burſts and tears away there when the Head ſwells; and having performed its office of defending the Head while young, it falls off, and fades away. The purple Plumule, at its point, Fig. 1, *e e*, which to an unwary eye might ſeem a Stigma, is nothing more than the withered extremity of the Rind of the Stalk. This Rind forms a Knot, or ſwelling, at the ſummit, and terminates finally in this lengthened and twiſted Cord. The Head has all its parts of fructification in itſelf.

THE thick lump of Fleſhy ſubſtance which crowns the Stalk, is properly the Receptacle of the Fructification: this riſes into a kind of Fruit, as in the Figure, ſee Fig. 2, and is not unlike to it in ſhape; but in this minute Plant there is yet a ſeparate Capſule within it. The hollow body within the cavity of the Head, is this Capſule, and it is filled with Rudiments of Seeds. The radiated Cover, *g g*, is a Crown of Antheræ, which, when more ripe, and open to the air, will ſeparate, and ſhew themſelves loaded with a fine Farina. This falling on the young Seeds, impregnates them, and they are then fit for growth.

IN the Plant in this flowering ſtate, theſe Antheræ are but imperfectly diſtinguiſhed: they riſe from the verge of the Head, and bending inwards at the point, form a kind of low green Cone, Fig. 1. *c*. When the hood is fallen off, they harden and grow brown; they ſtart at the Points, and then ſeparate at the ſides; and are ſoon diſtinct throughout, Fig. 1, *f*. Each is a flat Pyramid riſing from the Ring formed at the top of the Head, without any Footſtalk. The entire Crown is repreſented magnified at Fig. 4, and a ſingle ray of it at 5.

THE ſubſtance of theſe rays is reticulated, like all the reſt of the Plant, and they are covered with a delicate Membrane. The Farina is lodged in a kind of Chains, Fig. 4, *a a a*, round the ſubſtance of the Antheræ in many places. Theſe Chains are formed of ſmall oval Particles, ſee Fig. 5: theſe are the Globules of the Farina, incloſed in a ſingle Membrane, which keep them at a diſtance from one another: ſee Fig. 6. They are thus doubly, indeed trebly ſecured from the injuries of the air, while they are taking their growth; firſt by the Calyptra, or looſe Hood, which covers the whole Crown or range of the Antheræ themſelves; then within the outer Film of the Anthera, the chains of Globules being lodged between the Coat and Subſtance, ſee 5; and finally by the Membrane,


Swans Neck Bryum.

which connects them into that Chain. The Globules of Farina, entire and burſt, are ſhewn at Fig. 7.—Such care has Nature taken, of the Seminal Plantule of this ſmall Moss, before it is delivered to the Seed: for every Globule of this Chain contains a ſeparate Particle of the Fleſhy Subſtance of the Plant, riſing from the reticular body of the Anthera, which is a continuation of it.

WHEN this Farina is to be dropped upon the Seeds, the proceſs is this. The Hood, Fig. 1, a, firſt falls off; then the Antheræ, Fig. 1, *f*, ſeparate and harden; after this the Membrane which covers the Anthera burſts on the inſide, and along the edges, Fig. 5, and the Chains of Globules break and ſtart out in length; but ſtill the Membrane keeps its form. In this State the Anthera reſembles the Snout of the Saw-fiſh, ſee Fig. 5, having a multitude of Teeth on each edge. The two oppoſite Teeth are always the two ends of a Chain of Farina, which has broke on the inſide of the Anthera, where both the Membrane and this Chain are weakeſt; and a careful eye will trace eaſily the continuation of the line acroſs the Anthera.

AFTER a time the Membrane which forms this Chain burſts lengthwiſe, 6. Every Knot is a Globule of Farina, which, when the Membrane opens, falls out, and the Mouth of the Seed-Veſſel being open juſt below, it naturally lodges upon one or other of the Seeds. Each of theſe has a ſmall aperture in the Crown, and the Globule of Farina burſting, the Plantule, with its defence of waxy-matter, which it has exactly as the large Plants, makes its way in. Thus the Seed of this Moss is perfected; and, when it is hardened, falls from the Head, and grows.

I HAVE obſerved, that it has been thought theſe ſwoln Particles in the Head of a Moss were Globules of Farina, not Seeds; and that the Head itſelf, tho' it have plainly all the neceſſary parts of Fructification in itſelf, has been called an Anthera. Reaſon, and its conſtruction, ſeem to declare otherwiſe, and certainly experience does ſo.

THE eſtabliſhed Characteriſticks of an ANTHERA are, that it is a part of a Flower full of Farina. But the Head in this Moss is not a part, but an entire body, containing every thing belonging to a Flower, except Petals, which are of no conſequence, and are wanting equally in many of the larger and more ſpecious Plants. This HEAD is a CUP, formed as all other Cups of the outer Rind of the Stalk: the RAYS OF THE CORONA are ANTHERÆ, and their GLOBULES true FARINA. The hollow body in the Head is a real SEED-VESSEL; and the ſolid maſs from which it riſes,

together with the entire Shell of the Head, is a true and regular RECEPTACLE.

THE Characters of Farina are theſe: that it is a Powder, whoſe Particles burſt with water, and diſcharge what have been called elaſtick Atoms. LINNÆUS adopted from M. NEEDHAM, the idea of theſe elaſtick Atoms; but he afterwards calls the contents of the Globule of Farina, an impalpable Matter; which is more exact.

THE Globules from theſe Rays of the Corona are very ſmall; they burſt in water, and there is diſcharged from them what has been called elaſtick Atoms, or impalpable Matter. It is, indeed, a minute Particle of the eſſential Subſtance of the Plant, covered with a waxy Subſtance, which being incapable of ſolution in the watery Juices of the Plant, keeps in diſtinct Globules.

THEREFORE the Particles lodged in the Rays of the Corona in this Moss are Globules of Farina.

THE Characters of a Seed are theſe. It is a part of the Vegetable, containing the Rudiment of a new one, and ready to fall from the old Plant and grow; after it has been impregnated by the Farina. When a Seed is ſo minute as this of Moss, its diſtinction from a Farina muſt be ſought partly in its negative qualities. Now, this Seed is a part ſeparable by Nature from the old Plant, and capable of growth into a new one: It does not burſt in water as Farina, nor when purpoſely broken has it any of that waxy matter found in all Farinæ. There is, indeed, a Plantule in it, delivered from the Farina, juſt as there is in all Seeds.

THESE reaſons ſhew, the Powder lodged in the HEAD of Moss to be Seeds: If there be more proof wanted, take it from experience. The Plant here figured I raiſed from Seed gathered upon a wall at Weſtburn-Green, and ſown upon that low wall of the Hyde Park Reſervoir. This Seed was ripe in March. I ſowed it in the firſt Week of April, and the Plants flowered this February. Nothing is eaſier than the Proceſs of this minute article of Gardening. Scrape the ſurface of the Bricks, and of the Mortar between them, with a blunt Knife; take a large Tuft of the Moss in Seed-time, and draw its Heads over this rough ſurface; the Seeds will fall out, and tho' millions are loſt, enough will be fixed to grow.

THE firſt appearance of the young Plants was in the Beginning of May: they were green Specks, like Duſt; but a Microſcope ſhewed they had Leaves. They remained thus till Autumn; but then they grew faſt. The diſtinct Leaves appeared to the naked eye in October: four were ſpread out in a ſtarry manner, and two roſe in the center. In the next month

Various leav'd Polypody.

month they all grew cluſtered together, and began to form a Globule. From that time the Root increaſed very faſt; and in December the young Heads ſhewed themſelves: in February they ripened: and next month the Seeds will be perfect.

IN the ſame manner I have ſown the little GREY BRYUM, upon the North-weſt part of the Queen's ſeat in Kengſington Gardens, the ſtone-building near the water: theſe Seeds alſo were from Weſtburn green: another ſeaſon will ſhew the ſucceſs.

THIS is a point the more important, becauſe a Pupil of LINNÆUS, from what he obſerved in a very peculiar Plant, has ſuppoſed the Seeds to be Farina; and diſtinguiſhing the Rudiment placed elſewhere, from all Seeds, by the name of PROPAGO, has ſuppoſed other MOSSES like that; and the great Maſter himſelf adopts the opinion. Errors, ſupported by ſuch names, are very dangerous. Certainly in this Plant there are no ſuch propagines, nor any thing ſo ſingular. The regular Seeds ripen in Heads containing Capſules; and every Plant has one of them. The Plant, in its natural ſize in the various Periods of Growth, is repreſented at Fig. 8.

CHAP. XLV.

Of the VARIOUS LEAF'D POLYPODY.

IT has been ſaid in the Characters of the Seven Families of Plants, that the Ferns conſiſt of a ſingle Leaf, bearing the Seeds upon its back. Such are the upright Leaves, *a a*, of the POLYPODY here figured, as an inſtance of this family: See Plate 18: and ſuch, occaſionally, the lower and ſpread Leaves, *b b b*, might become: for howſoever different an aſpect they wear, they are capable of growing up to the ſame height, and of breaking into the ſame diviſions. When the Leaf grows up for Fructification, the indentings are continued down almoſt to the middle Rib, and the Leaf *b*, then becomes the ſame with the Leaf *a*, in all particulars.

IT is not particular to this Plant, among the Ferns, to have two kinds of Leaves, the one barren, and the other florid: our common Rough Spleenwort, and the Oſmund Royal, with many other, have the ſame Variations, tho' the difference in form is leſs; and therefore leſs conſpicuous.

THIS Plant is a native of the Eaſt-Indies; found principally about the Stumps of old Trees in their Foreſts. The Botaniſts of earlier periods were

were acquainted with it. CLUSSIUS calls it Polypodium Indicum; and others Polypodium folio Quercus. The Root is tuberous, irregular, and brown; uſually of an oval ſhape, and covered with a moſſy matter on the ſurface. The firſt Leaves which riſe from this, are oval, indented, of a browniſh green, and placed on ſhort Footſtalks: theſe defend the ſucceeding Leaves, which carry the Seeds of the Plant; and they ſeem formed for no other purpoſe. The ſucceeding Leaves are raiſed on Footſtalks, and deeply jagged, as our common POLYPODY; and theſe bear the Fructifications on their under ſides. Round Cluſters of Seeds are placed on the backs of all the Lobes or Diviſions; and in their various ſtages of perfection we may, in a great meaſure, trace their origin.

THE firſt appearance is a riſing of the ſurface of the Leaf, like a Papilla on the upper ſide; and this makes a minute hollow on the under part. By degrees the Papilla opens at the top, and there is an irregular, but roundiſh hole, with no green covering; but entirely white and ſpungy. At the ſame time cluſters of yellow Seeds uſually appear below; which increaſe in number, and, by degrees, the part of the Leaf over them loſes its prominent form, and becomes flat, and ſometimes hollow: the opening in the center ſtill remaining a plain white Spot.

To explain this opening, it muſt be obſerved the Leaf is formed of two colourleſs Coats, with a green ſubſtance, the Blea, between them; amidſt which ſeveral ſide Ribs run from the main Fibre in each Lobe, and inoſculate with one another, forming a beautiful reticulation. Theſe Ribs are Conic Cluſters, covered with a little Fleſh. Each, at its extremity, riſes thro' the green part, or Blea, to the ſurface, and forms a clubby Head, which is open to the air, and is white and ſpungy.

THESE Extremities uſually inoſculate; but toward the point of the Leaf they are often ſingle. From the Ribs, in their courſe, ſhoot others; and theſe laſt terminate in clubbed Heads in the middle of the Leaf. One of theſe always ſwells into the Papilla, and has its proper opening at the ſummit. Sometimes two of thoſe Papillæ are form'd ſo near, that they run together: but then each has its proper opening.

EVERY Seed-Veſſel is of a roundiſh form, and whitiſh; and its circumference is wound about with a jointed Ring. Each is ſupported by a long, delicate, tranſparent, Filament, by way of Footſtalk, which is terminated by the Ring: And all theſe Footſtalks riſe from the under part of the original Papilla. The ſubſtance of the central part of each Seed-Veſſel is ſpungy, like the open Head of the Papilla: The Ring is membraneous,

as

as the Verge of the Leaf is; and its Joints are brown. Therefore the conſtruction is this:

THE Papilla is the Receptacle of the Fructifications, formed from the white part of the Conic Cluſters. From this riſe numerous Filaments, crowned with their Rings of Antheræ: for each Ring is a Collection of Antheræ; every brown Joint of it being one. Theſe Joints burſt in water, as the Particles of Farina always do; but the central part never opens. This central part is in each a ſingle Seed: the miracle is its ſituation; inſtead of being lodged in a Capſule, it is fixed to the complicated Anthera, and contained within it: and when the Farina burſts, it receives immediate impregnation.

THUS the Proceſs of Nature in the Fern is the ſame as in all other Plants. What we call the Seed, is a part, or continuation, of the Central Subſtance of the Stalk; which, when it has received from the burſting Farina the Rudiment of a new Plant, ripens, defends it, falls, and burſting by the warmth and moiſture of the earth, grows.

THE Seed is at firſt an empty membranaceous Shell: when the Anthera has burſt, it appears full, and yellowiſh; and then being opened, we ſee plainly the Rudiment of a Plant, covered with a yellowiſh waxy matter.

WHEN the Antheræ burſt, a fine yellow, pulpy ſubſtance iſſues from them, ſo fine that it appears like ſmoak; and in the midſt of this is ſeen a ſmall oblong body, a minute Rudiment of a future Plant.

THAT theſe Joints of the Ring are Antheræ, is certain; for I have ſeparated them entire from the Ring, and ſeen their Powder burſt in that condition. They are oval and white: the brown colour they ſeem to have in the Ring being only ſhadow. I doubt not but the Fructifications of the other Ferns are of the ſame kind with theſe; and, probably, in many they are as diſtinct.

CHAP. XLVI.

LUXURIANT GRASS.

ANY GRASS would have ſerved for an inſtance of the Plants of this great Family; for all have huſky Covers for their Seeds, and ſimple Leaves, and jointed Stalks. Theſe are the moſt obvious part of the Character: and whether we examine the low GRASS that ſtarves upon the ſun-burnt wall, or the tall Wheat, at Harveſt, we ſee it equally: a ſimple, ſmooth,

ſmooth, and hollow ſlender Stem, ſwelling at diſtances into round, hard, paler, and more ſolid Knots, from whence ariſe the Leaves, covering uſually the Stalk for a conſiderable part of their courſe.

THIS is the viſible and common Character of the Family, and I have therefore ſelected a Plant which, beſides this, ſhews ſomething ſingular in the courſe of growth, a peculiar kind of luxuriance from the Rinds. This Species is frequent in our Northern Counties; and throughout all the colder part of Europe. VAN ROYEN and LINNÆUS of the moderns; and among thoſe a little earlier, SCHEUKZER and the BAUHINES knew the Plant. They have diſtinguiſhed it by the names Gramen Foliis Junceis, and Foliis Setaceis; the Ruſhy, or the Briſtly Leafed GRASS, from the rounded form of its Leaves: but with good nouriſhment they will grow ſomething broader.

SCHEUKZER ranges it among the Paniculate Spartean GRASSES; LINNÆUS once referred it to that Genus which he calls FESTUCA; but he has ſince removed it to the POA; to which, according to the Generic Characters, it moſt certainly belongs. The term VIVIPAROUS, which he has given as its diſtinction, is bold; but he has Genius with Philoſophy, and has called into the ſervice many Metaphors, and often happily. Strictly ſpeaking neither is it Proliferous, tho' SCHEUKZER, and the reſt, have diſtinguiſhed it by that title. There are GRASSES in which the Seed grows in the Ear, and will produce a perfect Plant; but this has leſs title to that term; and the utmoſt we can attribute to it, is a ſtrange and very pleaſing luxuriance of the Rinds.

THE Root conſiſts of many duſky Fibres, long, tough, thready, and not much divided. The Leaves riſe in ſmall tufts, and are perfect, but ſmall GRASS; narrow and firm. The Stalks are alſo numerous. In barren ground they will flower at three inches high: when the Soil ſuits them ſomewhat better, they grow to five or ſix inches, and ſometimes to a foot: and in this ſtate it is that the Plant is moſt perfect; and from this it oftenest grows luxuriant. The Stalk riſes ſurrounded with Leaves, and the whole Tuft with a few light Films.

THE Stalk has uſually three Joints, one of which is always near the Root, and ſcarce diſtinguiſhable, becauſe of the involving Leaves: ſometimes a ſecond is alſo very low: the upper one is always moſt conſpicuous. The Stalk is pale and thin. The Joints ſwell into a little roundneſs, and are hard. One Leaf, as is uſual, riſes from each Joint; ſlender and ſmall, as thoſe from the Root, or very little broader. At the ſummit ſtands a flat Ear,

Luxuriant Grass.

Ear, with the Huſks all turned, or nearly all, one way. Each has its ſlender Footſtalk, and they play a little looſe.

THE Huſks are of a greeniſh brown, and naturally terminate at the ſame ſmall ſize with thoſe of the other GRASSES, the Flowers having, like them, their three Filaments and feathery Style: but where the Soil and Seaſon join to give the Plant abundant Nouriſhment, the ſeveral Valves, or Parts of each Huſk, lengthen into abſolute Leaves, graſſy, and perfect as thoſe of the reſt of the Plant, only ſhorter.

WHAT has been ſaid of the Formation of the parts of Flowers, explains this; for theſe huſky Films are of the nature of the Cup in other Flowers; and being only the terminations of the Rinds of the Plant, more Nouriſhment may make them continue to grow: as the reſt of the Plant does not grow with them, they could not run into a ſimpler or more natural form: the Blades of GRASS which they conſtitute, being no more than extended Huſks, whoſe lengthened portion being full of Juice, and having had no check in its growth, is green and tender; while the Baſe, where Vegetation had begun to ceaſe, is hard and brown.

CHAP. XLVII.

Of the WINGED PALM.

AS in the preceding inſtance any GRASS might have expreſſed the Family of Graſſes, here any PALM might have been choſen for that purpoſe, reſpecting the Family of PALMS; all having naked Trunks, Leafy at the Top; and the Fructifications placed on a kind of Ear, and produced within a Scabbard. I have ſelected this as the moſt diſtinctive in the Characters; for its ſimply Winged Leaves diſplay the frondoſe Nature of the PALM Head, better than thoſe which, being more complicated, and divided, ſeem to be themſelves Branched.

AUTHORS of early time have known this ſpecies; and it is common and famous for its many uſes throughout the Eaſt, and great part of South America. The Fruit is the Nux Indica of AVICENNA, and the Tree itſelf the PALMA NUCEFERA, and COCCIFERA of the BAUHINES, and other Authors.

THE Root is black, and ſpreading. The Stem, or Trunk, is a Foot and half thick; and in favourable, moiſt, and ſhadowy places riſes to a great height. It is covered with the remains of certain Films, which grow

about the Rudiments of the decayed Leaves. It is ſoft at firſt, but hardens as the Tree ſtands longer. The Leaves ſpread only from the top; and in the midſt riſes a little above them a tender Cone, of a white juicy nature; which is the Baſe of the ſucceeding Leaves. This is delicate in taſte when the PALM is very young, and ſtill ſweeter when advanced to maturity; but in the middle ſtages of growth it is ſomewhat auſtere.

THE Leaves are elegantly pinnated or winged; and while young their ſeveral Lobes naturally and elegantly bend back, and often meet one another.

AMONG the Leaves riſe together the Fruit and Flowers. They are diſpoſed very ſingularly upon a kind of branched Ears; and theſe, while young, are covered by a filmy Scabbard; which, when it has burſt lengthwiſe, to let out the Ear, decays. The Flowers and Rudiments of Fruit are diſpoſed on the ſame Ear; the Fruit on the lower part, and the Flowers toward the extremities of the Branches. The Flowers are ſmall and yellowiſh; the Fruit is fixed cloſe on the ſtronger part of the Ear, and grows to a great ſize: woody on the ſurface, and filled with a peculiar Liquor, and a firm Pulp.

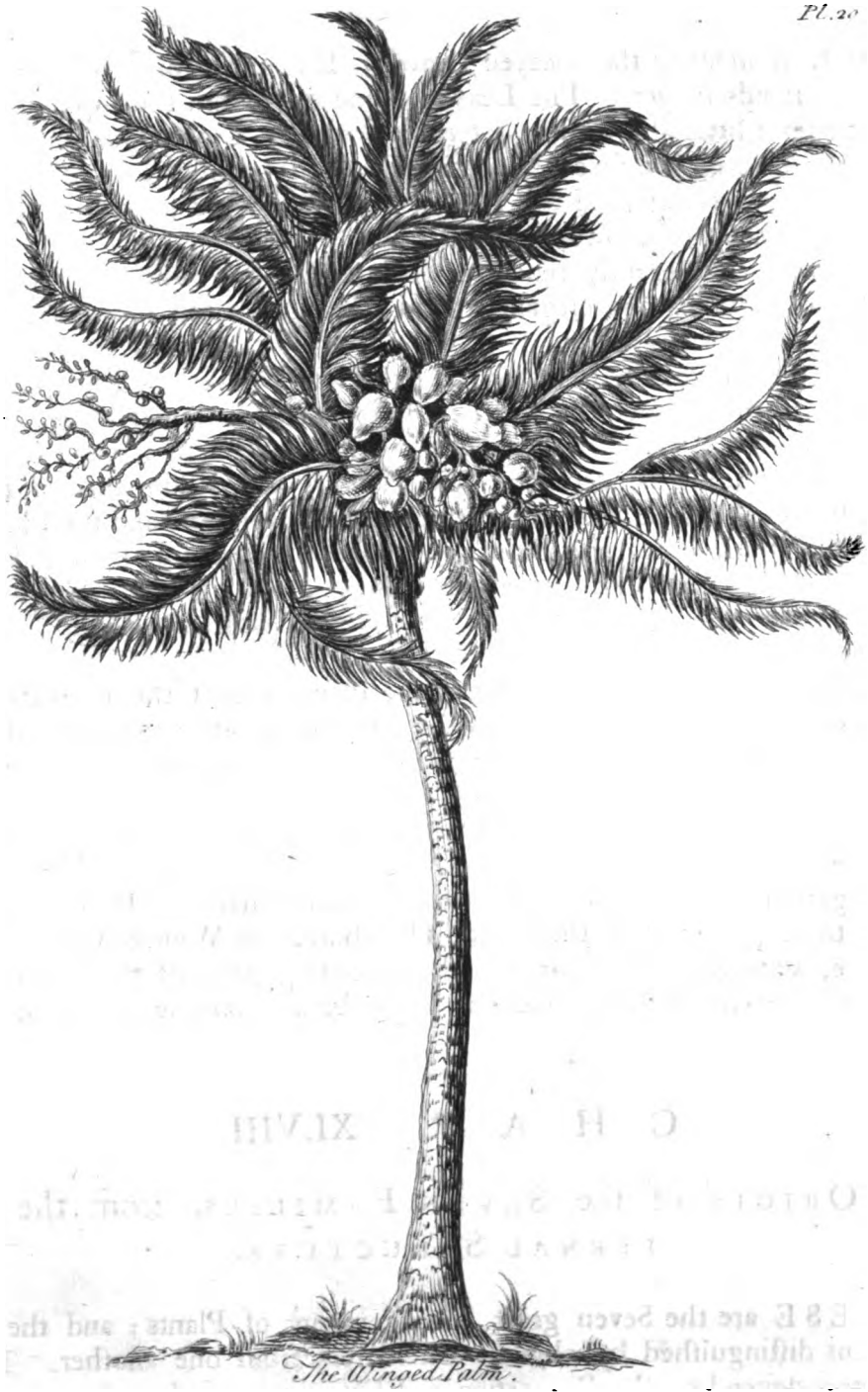
THE diſpoſition of the Leaves upon the Palm, and of the Flowers and Fruit upon the Ear, give a ſufficiently plain and certain Character of this Family: tho' Botany has yet a great deal to learn on the article of their Impregnation.

THIS is the ſixth of the Seven great and natural Claſſes called Families of Plants; the Seventh comprehends the common kinds of Herbs and Trees together; ſuch as have none of theſe peculiar marks. There needs no inſtance to be produced of theſe: the Hellebore, the Winter Aconite, and Anemone, with the reſt, figured in the preceding parts of this work, belong to the Seventh Family, and one might be an example as well as another.

CHAP. XLVIII.

The ORIGIN of the SEVEN FAMILIES, from the INTERNAL STRUCTURE.

THESE are the Seven great Arrangements of Plants; and they are thus diſtinguiſhed by obvious Characters from one another. Thoſe Characters depend on the Proportion and Diſpoſition of their ſeveral conſtituent



The Winged Palm.

tuent Parts; from which reſults that difference in the fabrick of their Veſſels, and in the courſe of their Juices, which is the immediate cauſe of the Forms which give thoſe Characters.

THUS in the MUSHROOM kind, inſtanced in the Truffle, the Fleſh being extremely ſmall, and making only a thin Membrane, is not able to raiſe itſelf up in a Stalk, nor to force out the other parts in Fibres: therefore the original Shell, or Annular Rudiment in the Seed, ſwells without producing any external part; and of neceſſity muſt form, and throw off, the new Annular Rudiments within its own body. Thus it is alſo with all the other Muſhrooms, whoſe various forms are no more than extenſions of the original Annule, in a more free manner; no one of them ever having the common appearance of Stalks or Leaves.

IN the ALGA the Coats as well as the Fleſhy Subſtance, are all thin: therefore the Plant can be only membranaceous. In the MOSSES, the inner Rind of the Root is the part moſt redundant, and beſt nouriſhed: therefore this forces itſelf out in form of Leaves; and even covers the Head with as plain a Reticulation of Veſſels. The proof of this appears upon a mere inſpection. We know all real Leaves have their proper Coat of Rind, their Subſtance of Blea, and their Ribs of Conic Cluſters: but what in theſe Plants wear the form of Leaves may be traced in a plain and ſimple courſe, from the inner Bark of the Root or Stem only: from this they riſe without receiving any other part: and their ſtructure is not that of Leaves, but is the ſame with that of the inner Barks of all Vegetables, a Reticulation of Veſſels within two ſimple Membranes.

IN the FERN kinds the Fleſh is ſtill weak, and thin, and ſeems no more than as a membranaceous Coat ſurrounding the Conic Cluſters; and riſing no where without them. Therefore no Flowering Stalk can be formed; but the Rudiments of new Plants are produced where thoſe Veſſels of the Conic Cluſters, which do not return, terminate in the body of the Leaf.

IN the GRASSES, the Veſſels of the outer Rind are large, numerous, compact, and hard: that Rind itſelf therefore has the ſame Character. The Fleſh, which is thin in all other parts, ſwells at the Originations of new Circulatory Syſtems in the lengthened Stalk; and hence ariſe the Characters of the Family. The Knots of the Stalk are owing to the ſwelling of the Fleſh, which is, indeed, no more than proportioned to the great length between Joint and Joint; and the natural hardneſs of the outer Rind gives the chaffy and dry firmneſs of thoſe Huſks wherein it terminates.

As the Moſſes are redundant in the inner Rind, the PALMS abound in Blea;

this forces itself out in numerous and vast Leaves, whose Bases, in a manner, form that Stem which they seem only to cover. And finally, in the common course of Plants the Flesh, as is most natural, has the predominance; and carries up the ascending Stalk, a firm, distinct, and vigorous support to the Fructifications.

CHAP. XLIX.

Of the EFFECT of LIGHT on PLANTS.

HAVING seen, in a variety of instances, what Vegetation is, and what the Bodies are which are produced by it, we might here close the present Enquiry: but there remains a point of great importance yet to be discuss'd; tho' it be one not generally conceived as relating to the subject. What HEAT and MOISTURE can effect, we have seen; but there is a third Agent, LIGHT, of equal efficacy; tho', in the midst of its own brightness, hitherto obscure.

THAT singular property which is called the Sleep of Plants, and which had been admired, tho' not understood, led me to those Enquiries, in which I found LIGHT to be the Cause; and those have led to others, new all of them, and all wonderful; from the result of which I may be bold to affirm, that Vegetables owe their Bulk and Quantity indeed, to the Earth, softened by Water, and actuated by Heat; but their Forms, their Colours, and, in a great measure, their Qualities, to this hitherto unconsidered Agent, LIGHT.

A SEED committed to the Earth will grow, tho' it be covered up in perfect Darkness, but the Growth will be weak, and the Body itself, in the highest degree, deformed: a Seed of the same Plant, covered as closely, but with a transparent body, will grow as free, and be as well proportioned, as in the open air. Thus, if two Peaſe be sown in the same Border, and the spot where one stands be covered with a Box of Wood, and that where the other is placed, with a Bell-glass of equal bigness. The Plant under the Box will be slender, yellow, insipid, and almost leafless; that under the Glass will have its natural Proportions, and proper Colour: the Leaves will grow regular, the Taste will be legunimous, and the whole Plant well formed, and green.

IN our common Gardens, the Anemone is poor in Colour when it is under the shadow of Bushes; and I last year observed at Sion-House, that even

even the common Lauruſtine loſt the Bluſh which adorns its Flower, entirely, under the imperfect Shadow of the Elm Walk to the Water; while ſiſter Shrubs of it, at a few yards diſtance, had the ſame Colour as thoſe in the reſt of the Garden.

THE Plants which grow in Caverns, and in Wells, tho' full of Vegetable Life, have very ſimple Forms; and ſcarce any thing of Colour beyond Green. They are all of one or other of the Four leſſer Families, FUNGUS's, ALGÆ, MOSSES, or FERNS, whoſe unconſpicuous Flowers confeſs the Obſcurity wherein they were formed: nor have they any ſtrength of Taſte or Colour. On the contrary, the moſt ſpecious Plants, the Roſe-Hibiſcus, and the Glorioſa, with their fellows, are children of the bright Sun of the INDIES.

ALL Plants are animated, as it were, by LIGHT: they have motions in their Leaves, and other parts, which they muſt perform, or periſh: on theſe motions depend the courſes of their Juices, and theſe are the effect alone of LIGHT. Thoſe which are leaſt animated eſcape common obſervation; but they have motions as certain, tho' leſs obvious; and thoſe which have the influence moſt fully, mimick the Animal Nature. It is hence the Senſitive Plants ſhrink at the Touch: for in the Dark they ſhrink yet farther: nor can any thing but LIGHT raiſe them to the condition of this ſeeming Senſibility.

THE Growth of Plants, at leaſt their regular Growth, as well as their abſolute Life, depend not only on Warmth and Moiſture, but on LIGHT: this moves their Juices, and upon this motion greatly depends their Encreaſe. If tender Plants be kept in conſtant Darkneſs, they loſe their Leaves, and die. Thus Mr. LEE, of Hammerſmith, at my deſire, making the Experiment moſt fairly, killed two Tamarind Trees, and an Abrus; and would have killed an Erythrina, but that he gave it LIGHT in time, and recovered it. LIGHT keeps the Juices of the Plant in motion; and this preſerves the whole. When it is not admitted theſe ſtagnate, and they ferment ſoon after; then the part falls off, and the Plant, wanting its neceſſary Organs, periſhes.

AS our LIGHT, which is interrupted by the Night, raiſes our Plants to Flower in a certain longer courſe of Time; thoſe which enjoy the ſhort Lapland Summer, riſe from the Root to full Bloom in a Fortnight: this is the effect of perpetual LIGHT, the Sun, for that time, then never ſeting. For the ſame reaſon it appears, that the Plants at the bottom of the Sea are, in all Climates, as deſtitute of ſpecious Flowers as ours in Wells: and while that univerſal glow is ſeen upon the Aſiatick Shrubs and common Plants.

Plants, thoſe which grow at the bottom of their deep waters, are as ſimple and as poor as our own. It is for the ſame Reaſon ſeveral Plants of the lighter Regions, tho' they grow freely, will not flower in our Stoves: and hence more LIGHT will make ſome flower in Europe, which elſe do it rarely and poorly. The Brunſwigian Amaryllis is one inſtance; and ſome of the more backward Aloes give another.

WHERE Vegetable Nature receives the greateſt Perfection in Form and Colour, there alſo the Virtues of Plants are found the moſt exalted. The Spices, and the fragrant Gums, come from the ſame bright Regions with the gayeſt Flowers; and from the imperfect trials we can make here, LIGHT has its ſhare with Heat in their Production.

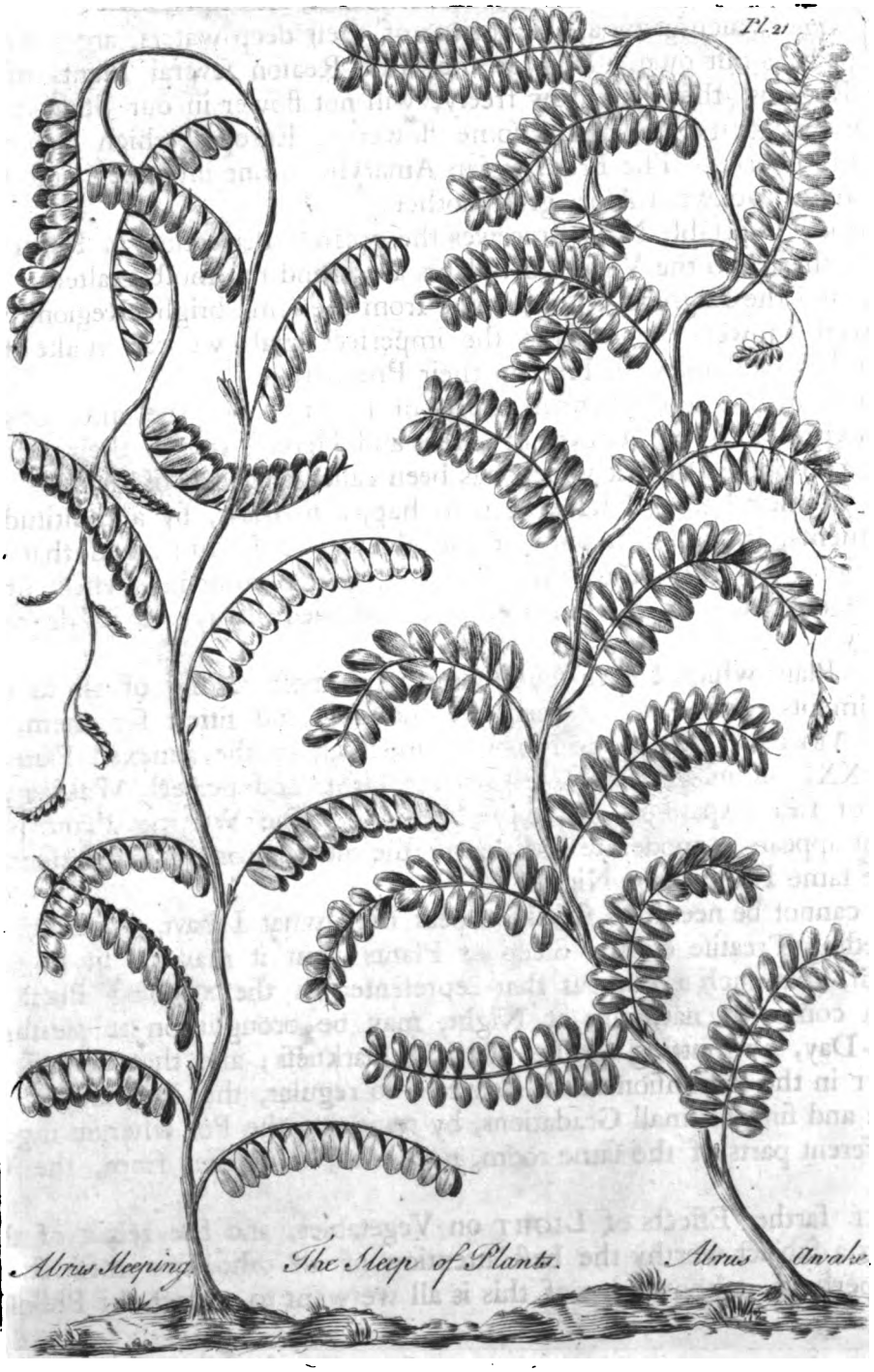
THESE are the moſt eſſential effects of LIGHT: but the moſt obvious is the expanſion of the Leaves of Trees and Herbs; this is their ſtate of Waking: oppoſed to that which has been called the Sleep of Plants. This cloſing of their Leaves I have been ſo happy to ſhew, by a multitude of experiments, is the effect only of the abſence of LIGHT; and that their Expanſion, which is called their Waking, is the immediate effect of the preſence of that great Agent; and is proportioned always to its degree or quantity.

THE Plant which I have found anſwer the moſt readily of all to theſe Experiments, and which is therefore the beſt and fitteſt for them, is a young ABRUS. Such a one I have repreſented in the annexed Plate, ſee Plate XXI. in its two ſtates of perfect Sleep and perfect Waking; the ſtates of full Expanſion and entire Cloſure. The Waking Plant is juſt what it appears in moderate Day-light: the Sleeping one is a repreſentation of the ſame Plant in the Night.

IT cannot be needful I ſhould repeat here what I have publiſhed in a preceeding Treatiſe on the Sleep of Plants; but it may be fit to ſay in general, that ſuch a ſtate as that repreſented in the Sleeping Plant, and which comes on naturally at Night, may be brought on at pleaſure at Noon-Day, by ſhutting up the Herb in Darkneſs; and that the effect of LIGHT in the Expanſion of its Leaves is ſo regular, that they may be made to riſe and ſink in ſmall Gradations, by removing the Pot wherein it grows, to different parts of the ſame room, nearer to, or farther from, the Windows.

THE farther Effects of LIGHT on Vegetables, and the reſult of them, affords a ſubject worthy the beſt attention of all who love theſe ſtudies: and, perhaps, a knowledge of this is all we want to perfect the Philoſophy of Plants.

INDEX.



INDEX.

INDEX.

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